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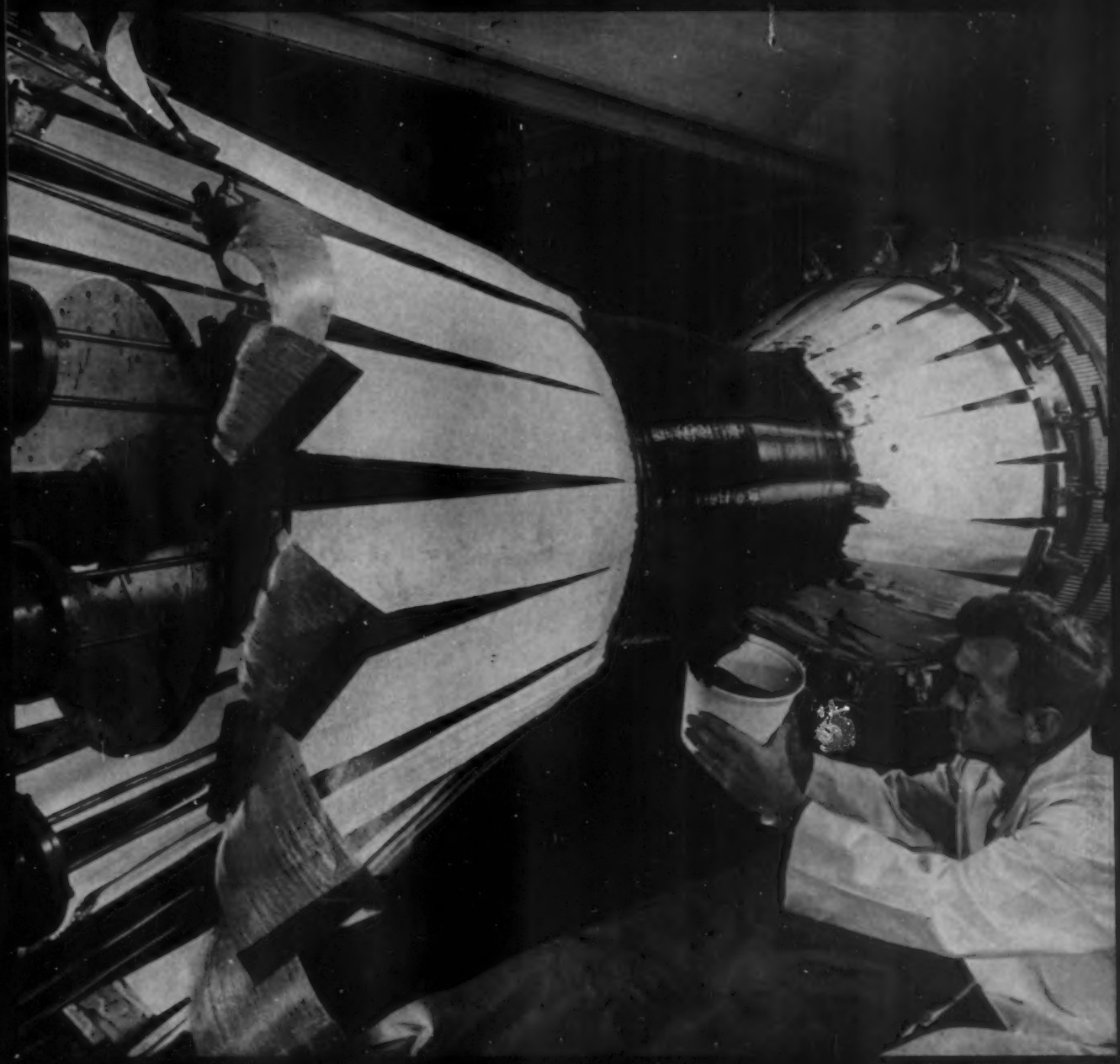
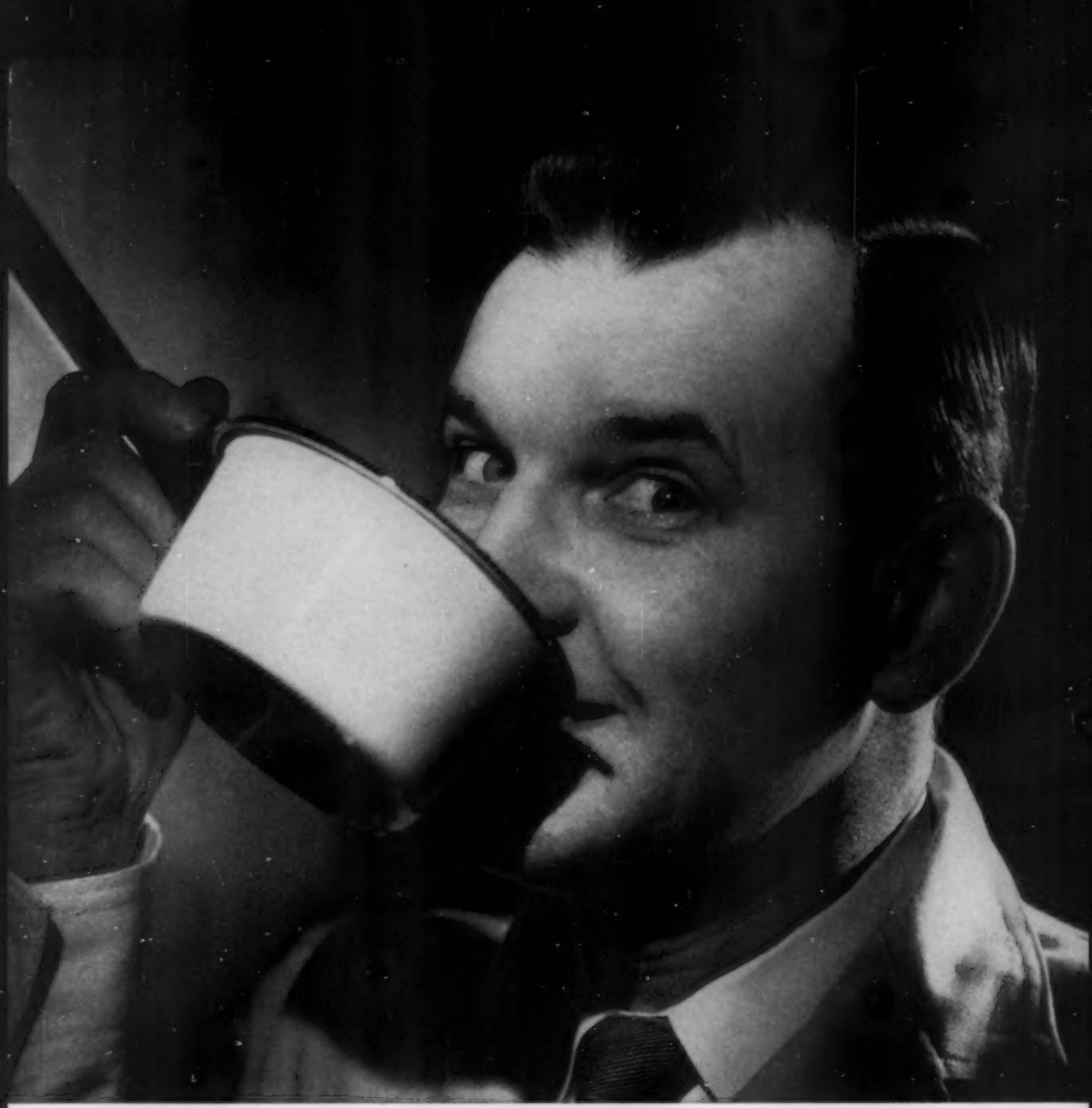
PRODUCT ENGINEERING

cGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT · APRIL 18, 1960



GIRDLE FOR ATLAS BOOSTER... see page 3



HE'S DRINKING A CORROSIVE LIQUID

It's only a drink of water, but it can be highly corrosive--the water source determines to a great extent just how corrosive it is.

Ground water from Utah, for example, is chemically different than ground water from New York . . . different enough to require a pump of different material to handle it most economically. In fact, there's nothing simple about handling water. Salt water, brackish water, hot water—each calls for a different pump material for best performance and longest pump life.

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PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

April 18, 1960 Vol. 31, No. 16

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New steels are born at Armco

18-8 STAINLESS Which type do you need?

Armco produces standard 18-8 (Type 302) Stainless Steel, of course. But we also supply a number of variations of this "18-8" analysis to meet your specific requirements.

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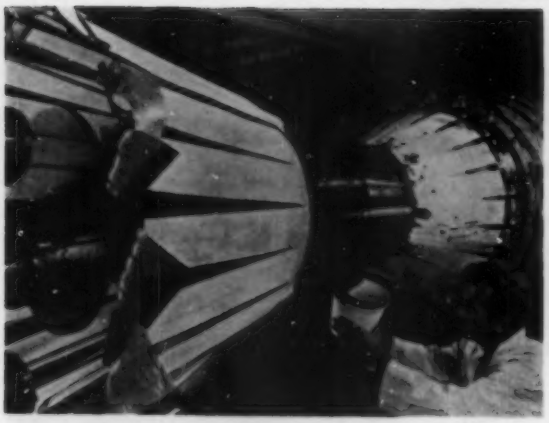
INTERESTING TO NOTE



On our cover—the combustion chamber of the Atlas ICBM booster engine is being wrapped in fiberglass. Glass roving is wound around a series of longitudinal fiberglass strips which replace the steel bands formerly used on these chambers. The technician is removing surplus epoxy resin, which impregnates the roving. Rocketdyne, a division of North American Aviation Inc, claims the process offers savings in both weight and cost.

Bring in the Astronomers

The mathematician has long been stereotyped as a foggy-eyed old man, dreaming about numbers, equations and graphs. Now, however, he is finding his place not just in the colleges and universities, but in industry as well. Today, he is often an important link in the chain of new-product development (p 76).

In 1730, one mathematician was also a clergyman. The Rev Hugh Jones, rector of St Stephen's parish in Cecil County, Md, was appointed chief mathematician for Lord Baltimore to handle a boundary dispute between Maryland and Pennsylvania. The trouble arose when William Penn was presented a grant from the Duke of York, which included New Castle and "all that tract of land lying within the compass or circle 12 miles about" the town. The problem was to locate the center of the town. Any deviation would mean a gain or loss of land for Maryland, so a commission from both Maryland and Pennsylvania met to solve the problem. The group from Pennsylvania accused Rev Jones of bias and of trying to enlarge his own parish by giving Pennsylvania land to Maryland.

For fifteen years both sides argued. Finally it was decided to dismiss the mathematicians and bring in two English astronomers, Jeremiah Dixon and Charles Mason. For three years they surveyed the southern boundary of Pennsylvania, following approximately the 36°30′ parallel. Aside from establishing the center of New Castle, so that Penn could have a clear title to his land (the northern border line of Delaware today is a perfect semicircle), they gave us a new boundary—the Mason-Dixon line.

Spotted Aphrodite

Of all games played in the world today, the oldest, and perhaps the most universal, are those played with dice.

continued on next page

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Strangely enough, the dice used today, whether in Las Vegas or the African veldt, differ little from those found in the tombs of ancient Egypt, classic Greece and the Far East. The actual origin of the game of throwing or rolling dice is obscured, however. Sophocles ascribed the invention to Palamedes, a Greek, who supposedly taught it to his fellow countrymen during the siege of Troy. More probably, dice originated centuries before the Peloponnesian Wars—with pebbles rather than marked cubes.

In Greece, dice-throwing was a favorite pastime, especially with the upper classes. Three dice were used—the highest throw, three sixes, was called "Aphrodite," while three ones were called the "dog." When the Romans picked up the game, they naturally changed the term "Aphrodite" to "Venus" but kept the term "dog." The Romans seemed to enjoy the game even more than the Greeks. The wealthy bought handsome carved-ivory cubes and, as a more extravagant touch, had dice of crystal inlaid with gold. Mark Anthony played dice prior to the battle of Alexandria; Caligula was known as a notorious dice-cheat and the emperor Claudius was so passionately fond of the game, he wrote a book on the subject.

Smithsonian Institution
Ancient Egyptian dice

Is it any wonder then that Caesar, on crossing the Rubicon to meet the force of Pompey uttered the words "*Iacta alea est*"—"the die is cast"? And speaking of cast dies, the article on page 65 tells modern decision-makers when the odds favor using zinc die-casting to cut costs.

The Strain in Spain

Imagine that you are a movie director. You are in Spain, not far from Madrid, filming a $6-million spectacular. You have spent weeks planning every detail of a 950 BC battle between King Solomon's troops and the hosts of mighty Egypt. When the moment arrives, cameras roll—horses, chariots and 4000 men in armor clash together. But in the sky over King Solomon's chariot, flies a modern multi-engine plane from a nearby US air base. Hundreds of feet of "Solomon and Sheba" have to be remade. This is one of the problems faced by those in the motion picture business today. Another is equipment.

As equipment to record images becomes more complicated (p 74), the task of making movies also becomes more difficult. Gone are the days when the only difficulties to hamper a movie schedule were caused by nature. King Vidor, for example, recalls the story of his filming "Birds of Paradise" in 1932. During the love scene, against an exotic background of Hawaiian palms, a hurricane hit the Islands. Every tree was stripped of its palm fronds. Instead of shooting the whole scene again, Vidor hired native girls to fasten thousands of tropical leaves back onto the trees and the picture was finished on schedule.

—Benedict A Leerburger Jr

NEXT WEEK IN PRODUCT ENGINEERING

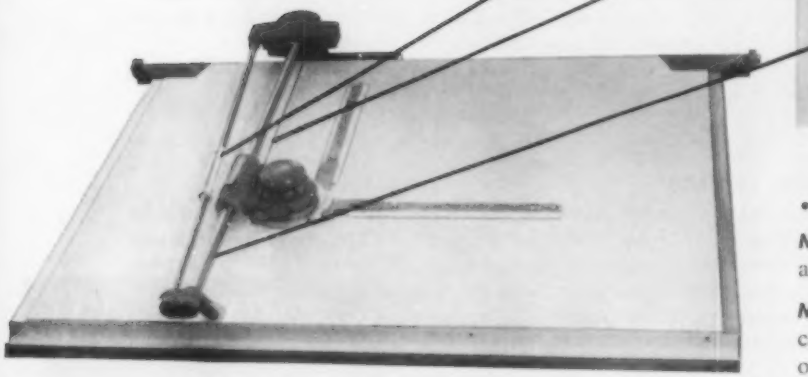
. . . **Hand Lay-up**
When lead time is short and you want reinforced plastics, this granddaddy of all the methods may be the best answer.

. . . **The Rare-earth Metals**
In industrial and government laboratories they're receiving top priority. Here's what they mean to designers.

. . . **Could You Pass a Russian Highschool Exam?**
Some examples of what is expected of Soviet students when they complete their 10-year study program.

. . . **Integral Ballbearings**
Although conventional ballbearings are made in a wide range of sizes, you can benefit in many applications by turning to the integral type.

. . . **Helical-spring Stiffness**
Charts give answers for any spring with mean coil dia from 1 to 30 in., bar sections from 1/16 to 4 in., and up to 20 active coils.



3 Ways Better

Horizontal positioning lock now centrally located to permit locking or releasing while seated.

Improved cable attachment and increased cable strength provide maximum protection against breakdown, cable-snapping, and the wear and tear of constant use.

Larger diameter vertical rail and attendant structural improvements afford increased rigidity for sharper, surer work.

5 Ways the Best

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More Compact – advanced travel-rod construction completely eliminates outdated cumbersome counterbalances projecting over top of board.

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2048

DEVELOPMENTS TO WATCH...

New batteries promise high output

High-current chloride batteries—primary and secondary, self-activating and rechargeable—have been developed by Three Point One Four Corp, Yonkers, NY, and will soon be in commercial production.

These are silver chloride and copper chloride units, claimed to deliver peak currents on the order of 10 amps/sq in., and said to represent a brand-new electrochemical system. Furthermore, the company says, they'll stand short-circuiting for an extended period of time and recover full potential rapidly. The company plans to make them in several standard sizes, with ratings from 300 ma/hr to 4000 ma/hr at 1.5 v for the silver chloride, and 1.2 v for the copper chloride.

Coming up next: a battery, 1½ in. dia and 6 in. long, which will deliver 3000 amps, and units that can be activated by sea water.

Combination bearings readied for use

Bearings that have oil-impregnated plastic bonded securely to steel sleeves can now be made in a wide range of sizes by Arguto Oilless Bearing Co. The plastic itself is a new bearing material announced by Arguto about a year ago (*PE*—May 25 '59, p 58); but now a technique that makes it possible to bond the material to steel as the thermosetting plastic is molded and cured permits the new design. No adhesive is needed. Details of the system and its design possibilities will be described in a forthcoming issue.

New fiber construction for better insulation at lower cost

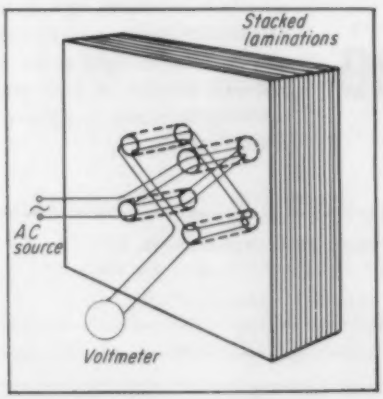
A flexible high-temperature insulation less expensive than standard asbestos-fiber constructions and showing better resistance to abrasion is claimed by Bjorksten Research Laboratories, Madison, Wis.

Key to both lower cost and improved performance is use of steel-wire reinforcement as a binding for bundles of short-fiber asbestos. The wire is a heat-resistant steel, wound around the fiber in an open spiral and so arranged that it serves as the warp (lengthwise fiber) in woven constructions.

So little wire is used, says Bjorksten, that the effect on heat transmission is negligible. But the increase in abrasion resistance is considerable; and use of short fibers in place of the long ones normally required should help cut the cost.

It should, says Bjorksten, "represent an opportunity for anyone seeking a lower cost flexible heat shield." The laboratory has patented the system, will license it for commercial production.

"Backward" transformer measures compressive stress



A transformer "gone wrong" forms the basis of a new load cell for measuring mechanical stress. Designed by ASEA of Vasteras, Sweden, the cell is, in effect, a transformer with the primary and secondary windings so placed that the coupling between them is zero in the unloaded state. However, if the unit (called a Pressductor) is subjected to compressive stress, permeability is reduced in the direction of the stress, and the flux is directed in the transverse direction by an amount proportional to the impressed force. Thus, if the primary winding is connected to an ac source, and the secondary to a voltmeter, a reading proportional to the impressed force is obtained.

LOAD-CELL CONSTRUCTION is diagramed here. Small, square transformer-sheet stampings, with symmetrically located holes, are stacked and glued together, forming channels in which the coils are wound.

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Nuclear powerplants take more than they give

Far from being a contributor to our total energy supply, our atomic energy program is still the biggest single user of electric power in the country, latest figures indicate. And it's likely to continue to be a net user of power for another decade at least.

Right now, Consolidated Edison notes, total industrial consumption of electricity is a little over 303 billion kwh/yr. The AEC takes about 55 billion kwh—nearly 18%.

Power is coming from the atom, of course, but the amount generated by nuclear plants is not even a drop in the bucket. The two big power reactors now in operation have a combined capacity of 240,000 electrical kw. Those now under construction, including Consolidated Edison's own big nuclear plant, will add about 567,000 by 1962, for a total of a little over 800,000. Our present capacity in conventional plants is about 220 million kw; and it's still going up.

When will atomic energy give more than it gets? Not likely before 1975. Even if its net consumption does not rise in the next 5 years, it will still be taking at least 13%.

Rubberlike materials resist heat and weather

Immunity from ozone cracking, low compression set at temperatures to 350 F, and good aging resistance in air to 425 F are among the claims made by Monsanto Chemical Co researchers for a series of vinyl copolymer elastomers being developed at the company's Dayton Laboratories.

The materials can be vulcanized, require little antioxidant, and accept standard reinforcements and fillers. Resistance to oil solvents is said to range from moderate to good, depending on the specific composition of the base elastomer.

Silicon carbide rectifiers head for commercial production

Offering twice the heat resistance and 100 times the radiation resistance of silicon rectifiers, silicon carbide rectifiers that have been under development for the past few years (*PE—Feb* 24 '58, p 8) are now in pilot production at Transitron Electronic Corp.

These are units that stand temperatures in the 930-F range and have reverse currents of less than 100 microamp at 50 v.

Limited-quantity, prototype orders are being accepted, at prices in the $40 to $50 range. Full commercial production is expected later this year.

British and French develop new readout system

A direct-reading system for data processing, using vertical printed lines to produce well-formed letters and numerals, has been developed by De La Rue of France and Bull Machines Ltd of England.

The vertical lines that make up the figures are not in themselves the critical factors. They simply serve as a visual system and also alert the interpreting equipment. It is the spaces between the lines; and, specifically, the disposition of wide (0.4 mm) and narrow (0.2 mm) spaces that is the key to the system. A normal numerical code is obtained by using six spaces (produced by seven lines) of which two spaces are wide and four are narrow.

The reading equipment is a magnetic pickup similar to that of a tape recorder. There are two magnetic heads. As a vertical line passes under the first magnetic head, a permanent field is generated, which magnetizes the ink. The line then passes under the second head, inducing a positive impulse. Simultaneously, a time base emits regular impulses, which are systematically fed into the input of a counter. When a positive impulse is received from the second pickup head, the counter total is read and reset to zero. The values read from the counter thus measure the intervals—long and short—between consecutive strokes. —ARG

VERTICAL LINES used in new data system are easy to print, and make characters that are easy to read, visually as well as magnetically.

WHAT'S HAPPENING IN RESEARCH . . .

Chemists describe heat-resistant fluids

Half a dozen promising approaches to high-temperature, radiation-resistant fluids and lubricants were outlined at the ACS annual meeting.

Among the hydraulic fluids under study are diaryl alkanes that offer resistance to thermal, radiolytic, and oxidative breakdowns; and alkyl-polyphenyl hydrocarbons, said to resist temperatures at least to 500 F (with some showing thermal stability to 750 F). The latter show excellent radiation stability but, in general, less satisfactory lubrication properties than compounds now in use.

As potential lubricating fluids, tetralykl silanes and metal-stabilized silicones are under investigation. The former, say Wright Air Development Center researchers, are stable to about 600 F, and resist oxidation at least to 500 F.

Silicone lubricants, stabilized by treatment with cerium soaps, stand temperatures in the 540 to 610-F range, say Naval Research Laboratory investigators, and they report "useful life is lengthened 30- to 500-fold." Other rare-earth additions, and additions of iron, copper, and chromium compounds, were also effective, but to a lesser degree.

For solid-film lubrication, phthalocyanines (*PE—Dec 9 '57, p 9*) continue to show promise. Battelle Memorial Institute says they have excellent lubricating ability at temperatures as high as 1350 F.

Naval Air Material Center reports that solid-film graphite and molybdenum sulfide lubricants prepared with sodium oxide–silicon dioxide binders are stable from −300 to 750 F, radiation resistant, and compatible with liquid oxygen; and initial tests indicate encouraging wear life.

Blisters measure coating adhesion

A test that uses liquid injections to measure adhesion of organic coatings has been devised at Shell Development Co.

As described by Hans Dannenberg, of Shell, the test involves formation of a blister under the coating by injection of a liquid (usually mercury) between the coating and the substrate. The amount of energy required to detach one square centimeter of the coating is then determined by recording the liquid pressure as a function of the injected volume and computing the area involved. A preliminary blank run is used to eliminate such extraneous factors as compressibility of the liquid.

Fiber composition affects tabulating-card performance

Variation in dielectric properties of paper fibers that can affect performance of such paper products as tabulating cards was detailed by T. D. Callinan of IBM at the latest TAPPI meeting. He reported that the dielectric constants and dielectric-loss factors of short unbleached sulfate fibers are twice as great as those of long fibers. This holds true over a frequency range at least from 0.1 to 100 kc, and means that cards high in long-fibered fractions possess lower dielectric constants and lower dielectric-loss factors than those high in long-fibered fractions.

The explanation seems to lie in differences in relative percentages of lignin, cellulose, and ash content that result in differences in moisture absorption.

(Note: for more on paper and wood fibers, see *PE—Feb 16 '59, p 50* and *Mar 7 '60, p 9.*)

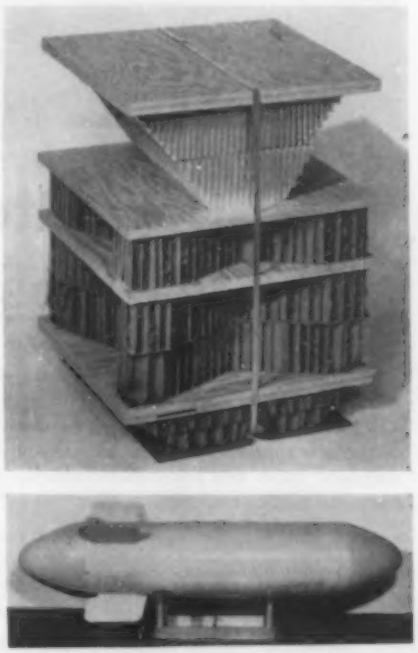
brief . . .

Higher capacitance per unit weight can be obtained by sintering tantalum at temperatures lower than those customarily used in the capacitor industry, say C. J. B. Fincham and G. J. Villani of National Research Corp in a report prepared for the Electrochemical Society. They've been exploring sintering processes and parameters at temperatures in the range of 2750 F, and have noted significant improvements in electrical properties of tantalum anodes so prepared.—ARG

Cutting the cost of impact tests

Cardboard and aluminum models substitute for nosecones of aerial-delivery containers in Quartermaster Corps' impact studies. The test "cones," made of paper honeycombs and aluminum foil, are one of several ways that QMC's Container Div are using to simplify and speed data collection. The simulated nosecones cost less than $5 (compared to $20 for the real thing) and duplicate closely the actual force-time curve of the real cone.

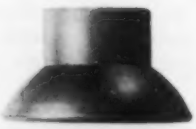
Another time- and money-saving idea: test drops are made in a 60-ft elevator shaft, with the elevator itself serving as a lifting device and an electrically activated bomb-release mechanism mounted beneath it to drop the load on signal.



PAPER CONE simulates aluminum aerial-delivery container for QMC impact tests.

Lower Motor Shock Mount

Coupler Housing Seal



Suction-Cup Foot (4)

Upper Motor Shock Mount

New kitchen appliance features key neoprene parts

When designers of the Hi-Vi fruit and vegetable juicer specified resilient parts for their new appliance, neoprene was their first choice for seven key components. Specified on the new appliance are: a neoprene coupler housing seal, neoprene upper and lower motor shock mounts, and four neoprene suction-cup feet.

Neoprene was the logical choice. It resists acidic fruit and vegetable juices; it resists ozone generated by the electric motor; it's unaffected by heat produced by the appliance. Most important, neoprene's performance lasts. Parts keep their resilience, do not age-crack or soften.

Manufacturers of major appliances are now using neoprene for gaskets, hose and tubing where a *durable*, resilient material is needed. Many neoprene parts are specified for automatic laundries, refrigerators and dishwashers, as well as for small appliances like the Hi-Vi juicer.

To find out how neoprene synthetic rubber can help solve *your* appliance design problems, write for a copy of our booklet outlining properties and performance. E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department PE-4, Wilmington 98, Delaware.

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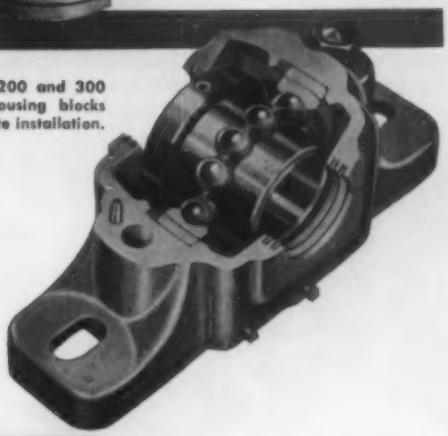
ball bearings by Link-Belt

Series 200—solid housing. For heavier applications Series 300.

Series JPS-200 provides low-cost, dependable self-alignment in a pressed-steel housing.



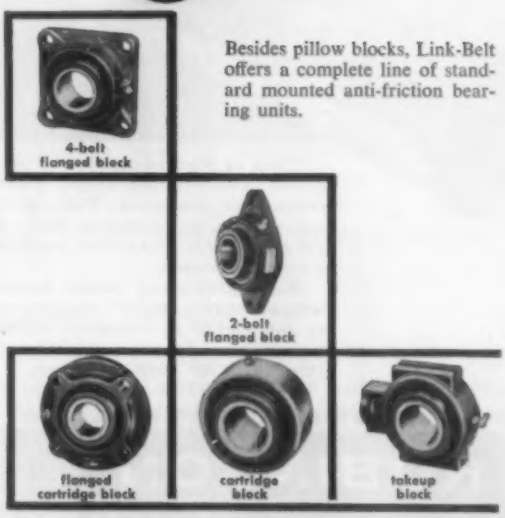
Series 200 and 300 split housing blocks facilitate installation.

HERE'S a line of self-aligning ball bearing blocks that satisfies every application need. And look at these design features. Precision, deep-groove, single row ball bearings for smooth operation and long life. Free-rolling action and full load capacity regardless of shaft deflection and misalignment. Self-aligning seals that protect the bearing and aligning surfaces . . . prevent entry of dirt, regardless of alignment.

Simple installation too. Slip bearing on shaft and lock it securely in position with spring locking collar. Slotted bolt holes facilitate mounting on supporting structure.

For complete information on this comprehensive line, contact your nearest Link-Belt office. Ask for Catalog.

Besides pillow blocks, Link-Belt offers a complete line of standard mounted anti-friction bearing units.



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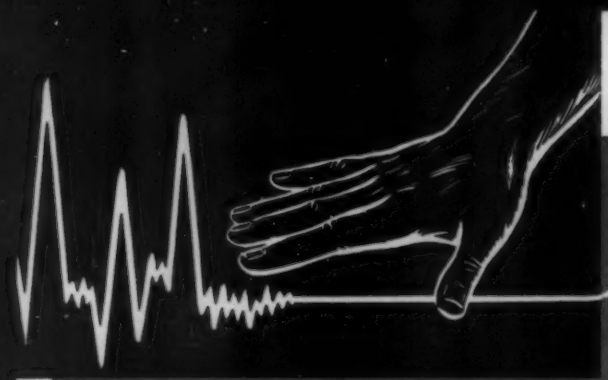
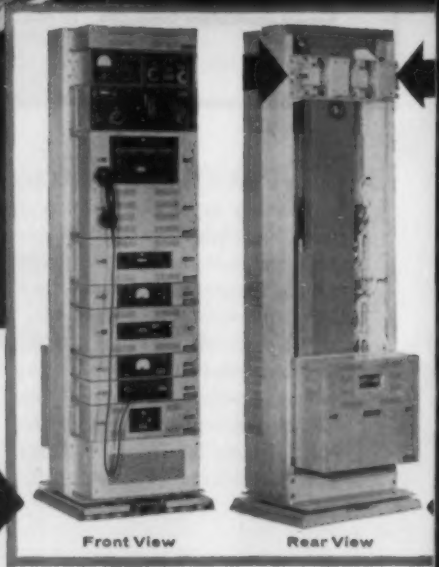


how ROBINSON *Vibration and Shock Control*

PROTECTS PERFORMANCE and assures RELIABILITY in Shipboard Installations . . .

Robinson has pioneered in the development and production of all-metal, low frequency vibration ***and*** shock mounting systems for the Navy's latest communications, radar, sonar and electronic computing equipment.

These are the **first all-metal environmental control systems** to be accepted by the Navy, and many are already in service aboard the latest missile cruisers, destroyers, aircraft carriers and nuclear submarines throughout the fleet.



Front View Rear View

This is Robinson Model W664-3 with the Collins AN/URC-32 single sideband shipboard transceiver installed. This all-metal mounting system includes a heavy duty, dual stage base and a stabilizer unit which is mounted on the rear of the equipment.

Exclusive dual stage concept and highly damped MET-L-FLEX® resilient cushions assure the full range of vibration isolation and shock attenuation—double protection for extra reliability! *Send for FREE brochures.*

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DESIGNERS AND MANUFACTURERS OF VIBRATION CONTROL SYSTEMS

CIRCLE 12 ON READER SERVICE CARD

FROM WASHINGTON . . .

Navy hopes to power atomic subs with thermoelectricity

The world's largest known thermoelectric generator has been put into operation. Navy sources say a 5-kw thermoelectric generator built by Westinghouse is now undergoing test runs at the company's new-products plant in Cheswick, Penna.

Ultimate goal is to operate Navy's nuclear-powered submarines with thermoelectricity. Main reason is to cut down on submarine noise, making them less vulnerable to enemy detection.

Efficiency of the Westinghouse watercooled, diesel generator has not been revealed. But Navy hopes to develop a thermoelectric generator with about 15% efficiency within 5 years. First models, however, aren't expected to achieve more than about one-third of this, a Navy spokesman says.

A second thermoelectric generator of the same size is being developed by the Carrier Corp. It won't start tests before early May, however. Both generators will burn fossil fuels but will be engineered differently, Navy says.

New translations of Soviet technical literature

Eleven new translations of Russian technical literature have been released for sale. They are of books and articles, and include information on such things as precision castings, 59-11937, 143 pages, $3; sealing of hydraulic units with metallic slot rings, 59-11989, 9 pages, 75¢; improving the dependability of pipe lines of hydraulic systems, 59-11984, 15 pages, 50¢; means of increasing stability, speed and efficiency of a hydraulic servodrive, 59-11992, 15 pages, 50¢; destruction of chrome-plated pieces due to grinding cracks, 59-11994, 13 pages, 50¢; and investigation of silicon photocells as converters of solar radiation, 59-21000, 11 pages, 50¢.

Copies of the translations can be obtained from the Office of Technical Services, US Dept of Commerce, Washington 25, DC. Order by number and title.

Missile makers attack problem of rocket contamination

A comprehensive guide to controlling contamination in liquid-fuel-rocket propulsion systems has been prepared by the Aerospace Industries Assn. Some 13 of the nation's top missile manufacturers contributed to preparation of the 75-page report.

Intended for all persons working on the design, development, manufacture, and handling of liquid-fuel-rocket propulsion systems, the booklet outlines ways to get finer tolerances through control of contamination. The report is available free from Aerospace Industries Assn, 610 Shoreham Building, Washington, DC.

NBS broadcasting low-frequency calibration tests daily

New low-frequency calibration broadcasts have been started by the National Bureau of Standards. **Its Boulder, Colo, Laboratory is now making daily standard-frequency broadcasts at 20 kilocycles. The broadcasts will enable users of electronic equipment for quality control of production, research labs, the electronic industry, and other industries to make frequent calibrations of their equipment.** Special receiving equipment may be necessary to pick up the low-frequency signals. The worldwide broadcasts were approved by the International Telecommunications Union last fall.

Titeflex, Inc., Meets Aircraft Fuel, Lubrication and Hydraulic Line Specifications with

HANDY & HARMAN BRAZE 541

Titeflex operator brazes assembly with torch and hand-fed Handy & Harman Alloy BRAZE 541. *Titeflex is unique in that it makes flexible hose assemblies from raw material to end product—"From End to End, Inside and Out, made RIGHT In Our Own Plant."*

This Springfield, Massachusetts, manufacturer of aircraft and missile fuel, lubrication and hydraulic lines finds that silver alloy brazing with Handy & Harman BRAZE 541 meets rigid operating requirements "all the way down the line."

The tubing and fittings of many of the wide range of assemblies made by Titeflex are 321, 316 and 347 stainless steel and Monel. Brazing is a hand torch, wire and HANDY FLUX operation.

BRAZE 541 is a plastic alloy which melts at 1325° F and flows at 1575° F. Its strength—in shear—at elevated temperatures is 21,500 psi at 500° F and 15,000 psi at 750° F. This alloy's ductility in resisting stress and vibration is very high and its resistance to oxidation and corrosion is equally impressive. The composition of BRAZE 541 is 54% silver, 40% copper, 5% zinc and 1% nickel. It meets AMS Specification 4772.

Aircraft and missile component manufacturers and fabricators are finding—to their and their products' benefit—that Handy & Harman silver alloy brazing is the full and *final* solution to their metal-joining problems. BRAZE 541 is but one of a large family of Handy & Harman alloys, for both low and high temperature applications. We would like to more fully acquaint you with BRAZE 541 and with the advantages that come naturally to silver brazing as a metal-joining (both ferrous and nonferrous) method. Handy & Harman, 82 Fulton Street, New York 38, N. Y.

FOR A GOOD START: BULLETIN 20

This informative booklet gives a good picture of silver brazing and its benefits . . . includes details on alloys, heating methods, joint design and production techniques. Write for your copy.

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THE ENGINEERING WEEK

Flight Recorder Analyzes Aircraft Malfunctions

- **British firm develops lightweight recorder and ejection system. Equipment has two-fold purpose: gather data for maintenance and statistical purposes; permit analysis of important parameters in crashes.**
- **Multiplexing system gives 300 parameters on 6-channel tape. Possible other uses: where mass data is needed but space and weight are limiting factors.**

LONDON—The worldwide rash of military and civilian air crashes has reawakened interest in survival-type recording equipment—the kind that is automatically ejected in an accident.

Such equipment has usually been cumbersome, has lacked sufficient data storage, or been impossible to eject. But now, Royston Instruments Ltd, Byfleet, Surrey, England, has developed a recorder that tapes up to 300 factors affecting airframe and engine performance, and ejects the tape cannister in the event of a crash. The company reports that this equipment, weighing only 37 lb, may become standard on all British aircraft.

Of equal importance, say airline executives, maintenance men and government agencies, is the gathering of valuable records for maintenance and statistical purposes—instantly available, in any form, for any airplane.

TWO VERSIONS AVAILABLE

The recorder has 6-signal channels and a time-code channel, but a multiplexing system enables a maximum of 300 parameters to be recorded. It is made up of three units: power supply; time-sharing switch and tape cannister with ejection mechanism; float and homing beacon. Power supply runs from the aircraft electrical system—generally 400 cps ac—and includes a frequency stabilizer to ensure constant tape speed. Total power consumption is 190 watts.

Two versions of the system, known as Midas, are available—civil and military. Difference is in the time-sharing switch speed. For military purposes readings are taken every 1.6 sec; civilian aviation does not need as many closely spaced readings so switch speed is every 5 sec.

MULTIPLEXING—KEY TO SYSTEM

Multiplexing works as follows: Parameters to be recorded are divided into six groups, one group to each channel. A synchronous motor-driven, time-sharing switch revolves 1 rev every 1.6 or 5 sec, depending on the system. Each parameter, in turn, is connected to its appropriate channel for a fraction of the recording time. Associated with the time-sharing switch are a synchro converter and an rpm/frequency converter. These change output signals, from 3-wire synchros and similar devices on the aircraft instrument system, into analog form.

The light-alloy ejectable pack contains 900 ft of tape, giving 10 hr of recording at 1.6-sec switch time. For civilian application, tape footage is increased to give 160 hr at the 5-sec speed. A standard tape velocity of 0.3 in./sec is used.

EJECTION TRIGGERED 3 WAYS

Ejection power source is a diesel starter cartridge, ignited by a constantly charged battery. This cartridge, sealed and operable 30 ft below water, fires into a piston-cylinder arrangement that ejects the pack 150 ft at a 45° angle. Pack acceleration is less than 45 g.

The mechanism can be triggered in three ways:

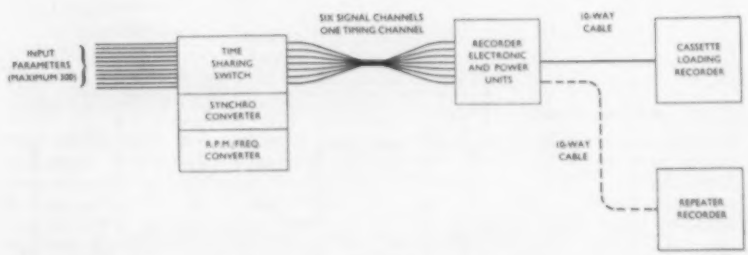
- By high-level "g" switch that initiates ejector on impact.
- By heat-sensitive switches placed between recorder and possible fire sources.
- By hydrostatic pressure switch of the g-balanced bellows type that operates when immersed in more than 3 ft of water.

Unit can be held in the main airframe by a locking screw and shear pin, and ejected through a frangible panel; or a panel secured by explosive bolts arranged to fire simultaneously with the ejector cartridge.

PLAYBACK AT HIGH SPEED

Playback equipment runs 100 times faster than the recorder and includes an electronic decoding switch to separate the original parameters. Individual outputs are then fed to a plug-in patch panel, custom-built for each installation, for routing to the processing circuits.

Data reduction and readout are ar-



DATA RECORDING SYSTEM for civilian aircraft parallels the main recorder with a repeater recorder, which is ejected in emergency. A continuous tape loop duplicates last 60 min. of flight performance data—automatically recorded and transferred to spool as older material is erased.

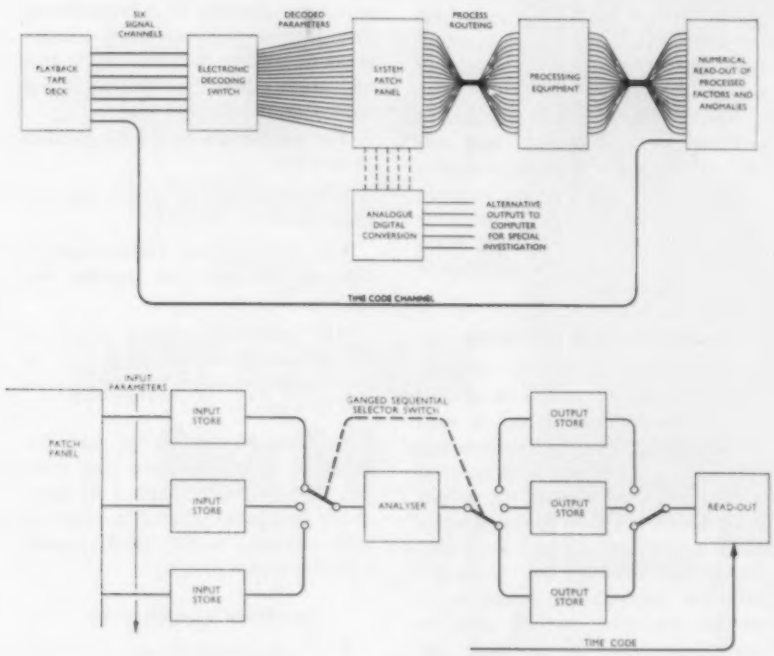
ranged to simplify the mass of recorded data. For example:

• Parameters significant only if exceeding a predetermined value are extracted and readout consists of an automatically typed record of the over-level factors against time.

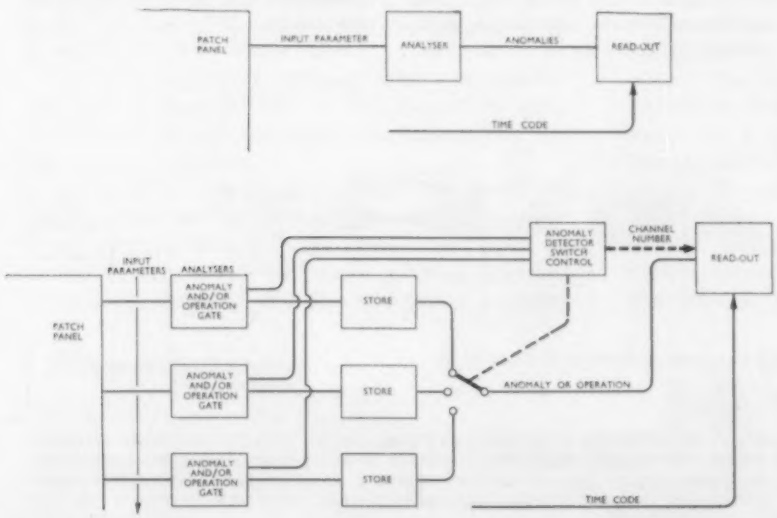
• Where cumulative records are required—such as of engine wear—individual factors are processed via non-linear networks and a value giving a cumulative total is computed.

To save individual analysis and readout equipment for each parameter, input stores are included and selected in sequence, passing signals to a common analyzing circuit. An alternative system allows sharing of readout by circuits requiring different types of analyzers. Detection of an anomaly by any analyzer operates a switch connecting the correct circuits to the common readout.

—Nick Landon, London



PLAYBACK AND DATA REDUCTION SYSTEMS permit variations for continuous analysis and readout (top), shared analysis and readout (above), or shared anomaly (below), and operation presentation (bottom).



Germans Consider Expanded Reactor Program

BONN—Preliminary discussions among nuclear industry, the atomics ministry and the atomics commission may signal a new reactor program here. Though still hush-hush, subject of the discussions appears to be financing of one 50-mw reactor and four or five 20-mw reactors—all of German construction and design. The government will probably present this program to the International Atomic Energy Agency in Vienna this fall as Germany's contribution to the aid program for underdeveloped countries.

If the program goes through, the 50-mw reactor will be a Siemans pressurized boiler designed for various applications: materials testing, nuclear-fuel testing, power generation, etc. One of the smaller units will possibly be built through a licensing agreement with Britain's General Electric.

All of the 20-mw reactors would be pilot models similar to the 150-mw project-S power units for which these companies are presently carrying out design studies. The 20-mw models may differ in details, however, because risk will be reduced when incorporating new technical features.

At present a snag is that no buyers for these reactors are in sight. The smaller cost of the 20-mw reactors may attract customers who have shied from heavy investment in the 150-mw units. Should these hopes fail, the government, which is becoming more willing to engage in reactor study for developing countries, may step in.

Nearly everybody here will be happy if German reactor construction gets an overdue uplift. Germany needs experience in design and operation. The atomic minister, Dr Siegfried Balke, and German industrialists have stressed that Germany will become scientifically backward in related fields of chemistry, control engineering and machine building unless reactor programs are encouraged. ■

Finish-machining of Massive Mandrel

An aluminum hand forging, produced by Alcoa, is here being finish-machined by Douglas Aircraft Co Inc. Machined forging is 144 in. long, with its dia tapering from 24 to 3 in. Following machining, the aluminum part will be plated with nickel. The aluminum mandrel is separated from its nickel coating by cooling it to subzero temperatures, leaving a perfectly formed nickel shell. It will be used as a liner for the Mach 6 (4500 mph) nozzle installed in industry's first hypersonic wind tunnel. Tunnel will produce speeds to Mach 10 (7600 mph.)

High-temperature Measurement Poses Special Problems

CHICAGO—"We have reached a point in high-temperature research where we no longer know what temperature is." This statement epitomizes anxiety expressed by some 500 scientists from Britain, West Germany and the US attending a recent symposium on optical spectrometric measurements of high temperatures conducted here by the Univ of Chicago.

The statement was made by Thorfin Hogness, deputy director of the university's Laboratory for Applied Sciences, who added that many scientists are finding it difficult to define temperatures above 9000 F, and to develop instruments which give reliable measurements in those regions.

Although far from agreement on solutions to their problems in high-temperature measurement, most scientists attending the three-day meeting agreed that classical mechanics is not enough.

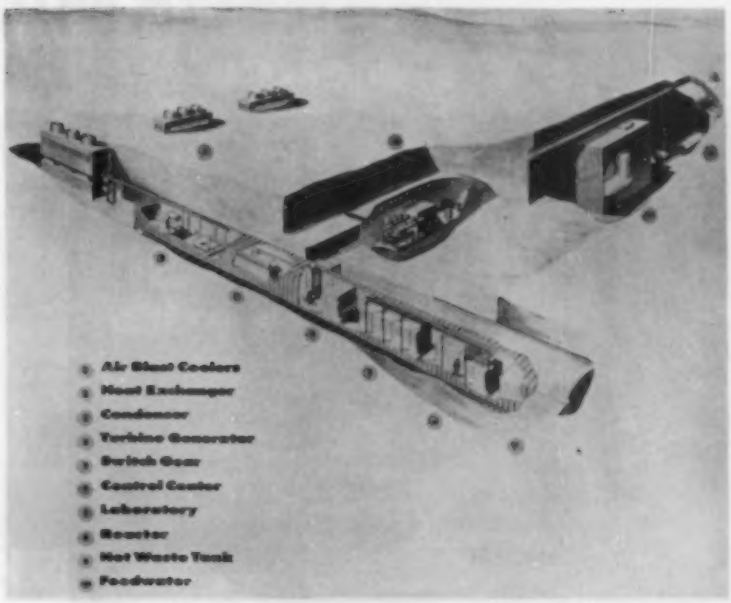
For example, Dr Richard Thomas, astrophysicist with the National Bureau of Standards (NBS), called for new approaches, particularly in quantum mechanics. He urged setting up a national astrophysical laboratory to establish atomic constants and aid in theory development.

"Without precisely known atomic constants, work on high temperature and related problems cannot progress much further," said Dr Thomas, adding that such a laboratory might be administered by NBS.

Dr P. C. Thonemann, British Atomic Energy authority from Harwell, reported a fairly unified program

continued on page 20

Skid-mounted Power Reactor for the Arctic

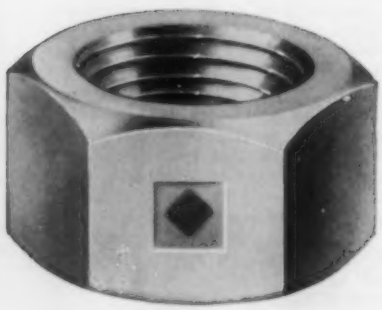


First remote-area installation of atomic power is planned for Army base in Greenland. Components of the pressurized-water, prefabricated nuclear powerplant are undergoing tests at Alco Products' plant. Called PM-2A, the plant will deliver about 1560 kw of electricity plus about 1 million btu's of steam for district heat. Its output is developed from a nuclear core burning enriched uranium. Conventional fuel needs per year would be more than 850,000 gal. of diesel oil—over 15,500 55-gal drums. Alco and Army officials say PM-2A will operate 12 months on a single loading of nuclear fuel—eleven 55-gal. capacity drums. Plant comprises 10 skids that hold all station generating equipment. For air shipment, the plant breaks down into 27 packages. Max weight of a single skid is 15 tons; largest skid is 28 ft long, 9 ft high, 8½ ft wide.

Bill Spurs Research

WASHINGTON—Rep Victor Anfuso (D-NY) has introduced a bill aimed at encouraging basic scientific and technological research. The bill would entitle defense contractors to an additional 10% of the total sum of their contract if they work on basic and supporting research. It would be limited to contracts worth at least $50,000. ■

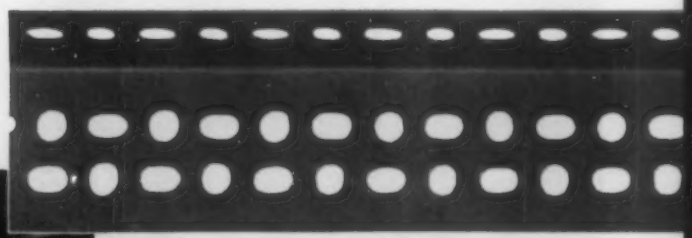
PERFORMANCE UP...



ROBERTON MANUFACTURING COMPANY, Chicago, Illinois, uses 44 Republic NYLOK® Self-Locking Fasteners to hold power units firmly in place in their Roberton Twin Power Riding Mowers. NYLOK'S special nylon inserts assure positive locking in any position. Displacement of the insert produces strong lateral pressure, preventing any play despite extreme vibration.

ACME STAMPING & WIRE FORMING COMPANY, Pittsburgh, Pennsylvania, uses Republic Type 302 Stainless Steel in the production of tough, corrosion-resistant friction bands for outboard motors produced by Evinrude Motors, Milwaukee, Wisconsin. Used on pivot shafts, the bands measure .062″ x $^{15}/_{32}$″. Fabricating operations include punching, forming in a four slide machine, and brazing on the loop end. According to Acme, ENDURO® Stainless Steel supplied by Republic is exceptionally uniform . . . assures higher product quality at lower unit cost.

COST DOWN



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CIRCLE 19 ON READER SERVICE CARD

continued from page 17

similar to that suggested by Thomas has been working successfully in England for some time. Thonemann emphasized, however, that much important work is done by private research groups and large universities.

Prof Walter Locht-Holtgreven of the Institute for Experimental Physics, Univ of Kiel, taking a different approach, called present mathematical tools sufficient to solve high-temperature problems. "We need insight into the problems, not new mathematical tools," he said. "We must know what assumptions to make, and when."

Asked what instrumentation is needed now for high-temperature research, Frederick Brech, Jarrell-Ash Co research director, replied "High-speed, high-resolution spectrographs. Phenomena lasting millionths of a second must be measured with greater precision and resolution than is possible with present instruments."

Dr Lawrence Aller, Univ of Michigan astronomer, suggested that the black-body concept might be of use to the high-temperature theoretician. He considered using a black-body model that emits the same amount of energy as the hot gas in question, and then finding the black-body temperature by mathematical means. This would give an effective temperature, but its use would be limited to theory, according to Dr Aller.

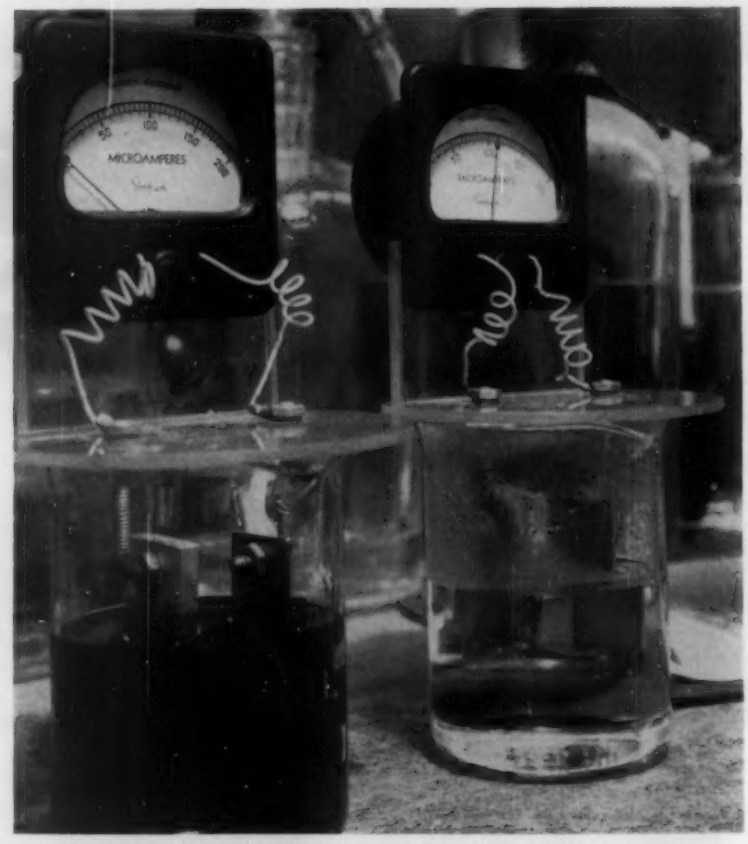
Secrets of controlled-fusion power and space flight are hidden in the mysteries of high temperature. The realm above 9000 F is unlike anything in the normal world. There are no solids, only gases—and these gases do not always act in the way scientists expect. It is a world in which quantum parameters become significant.

As temperature rises, molecules break down into individual atoms. With further increase, atoms are stripped of their electron shells, and eventually only atomic nuclei remain. Changes occur with increasing rapidity, and the random effects of Brownian motion disappear. The scientist becomes interested in events lasting only millionths of a second, and begins to look at specific points in the hot gas rather than at average or random effects.

Each of the various kinds of particles possesses a different amount of energy, and the concept of one temperature for a hot gas becomes unrealistic. It is possible to have several temperatures existing at the same place and at the same time. At ultra-high temperatures, each group of particles radiates energy at different wavelengths. To measure such temperatures, therefore, the scientist must specify which frequency he is considering, at what time, and at what place.

—Bruce Cross, McGraw-Hill
Midwest News Bureau

Color Check for Cooling-system Antifreeze



Effectiveness of the new-type inhibitor found in DuPont "Telar" antifreeze and antirust coolant is shown on ammeters. The instruments measure electrochemical activity between two similar sets of metal samples submerged in a solution of "Telar" (left) and in tap water. Absence of current flow through the "Telar" indicates no electrochemical action which could cause corrosion. If a leaky water pump, hose connection, or cylinder-head gasket lets air or corrosive exhaust gases into the antifreeze solution, contaminating the coolant, the fluid changes from a normal red color to yellow.

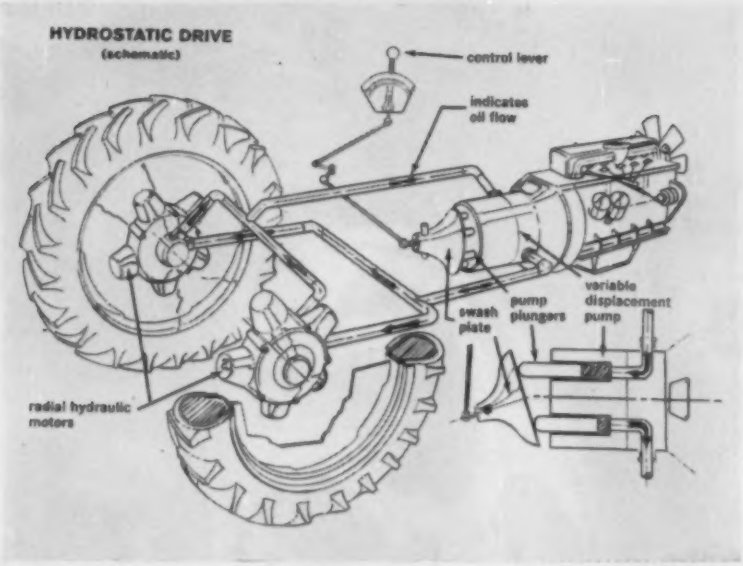
Soviets to Steer Space Ships with Artificial Hands

WASHINGTON—Soviet scientists claim to have developed a mechanical hand that will help pilot space ships of the future with superhuman skill. The claim was reported by a USSR scientific journal translated by the US Commerce Dept.

According to the report, the mechanical hand will be attached to a human astronaut and will be controlled directly by muscular currents. "It will be sufficient for the pilot of an interplanetary rocket to merely think of executing one or another action in operating the rocket, and the artificial hand will immediately and unerringly perform this activity," the report states.

A model of the device is said to have been developed at the Central Institute for Prosthetic Devices in Moscow. ■

Hydrostatic Drive Tested by Tractor Maker



Under evaluation by International Harvester researchers is a tractor with hydrostatic transmission. The system has three major parts: a pair of radial piston hydraulic motors—one in each driving wheel—and a variable-displacement swashplate-controlled piston pump which furnishes pressure energy to the system. Pump is coupled directly to tractor engine. Tractor speed can be varied from forward to reverse by changing angle of the swashplate in the pump. If increased torque is required at one wheel for a short turn, oil pressure can be wholly diverted to it. In this research model, the operator can control engine speed for added horsepower. Tractor controls also include a load-governing device which automatically reduces forward speed to increase torque on slopes or rough terrain. At present the advantages of easy control and infinitely variable speed are somewhat outweighed by high cost of components and poor fuel economy. Research is aimed at overcoming these handicaps.

Ceramic Engineering Scholarships Go Begging

New Brunswick, N. J.—In a recent survey, the American Ceramics Society found that less than one-half of the scholarships available for ceramic engineers in 1959 found takers. This means that nearly $100,000 worth of educational opportunity was lost through default, the society points out.

In discussing scholarship losses, the society says that few students seem to realize the scope and importance of the ceramic industry, although it ranks as one of the largest, with an estimated annual output of $7 billion. And hundreds of labs are conducting research to learn new and better ceramic applications.

Because of the growing importance of ceramic engineers to industry, graduates usually average a choice of 8 jobs. Many starting salaries exceed $7000 a year. The average salary for an experienced engineer with a bachelors degree is $10,000; with a graduate degree, $12,000.

In conclusion, the society says that the number of students taking ceramic engineering could be doubled without adding school facilities. ■

State Dept to Assign More Science Attaches

Washington—The US State Dept has asked Congress for permission to assign technical attaches in Latin America and Mexico.

According to the House Appropriations Committee, the State Dept wants a science officer located in Lima, Peru. The officer would tap areas of scientific activity . . . such as cosmic ray studies in the Andes, meteorological studies (of value to airlines and agriculture), and satellite tracking in remote areas.

Other assignments include sending a commercial officer to Paraguay, a minerals expert to Mexico, an aviation officer to Venezuela. ■

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Gaskets - Cardboard - Fibre
Polystyrene Foam - Canvas

For fluid adhesives; solvent rubber cement, latex, phenolic cement, epoxy cement, glue, polyvinyl cement; for pressure-sensitive, wet, contact and re-activating applications.

Save 35% time. Easy to use. Eliminate slow brush daubing. No adjustment for sheet size or shape. Clean, neat results due to accurate cement control. Uncoated side of sheet stays clean.

Coat sheets, die-cut and moulded pieces ¼" x 1½" and larger. Thicknesses: .003" to 4". 3" to 60" wide rollers. Bench coaters for short runs. Conveyor machines for production.

Schaefer
MACHINE COMPANY, INC.
135 FRONT ST. • BRIDGEPORT 6, CONN.

CIRCLE 21 ON READER SERVICE CARD

DAYTON POLY-V® Drives provide new approach for project development at Borg-Warner

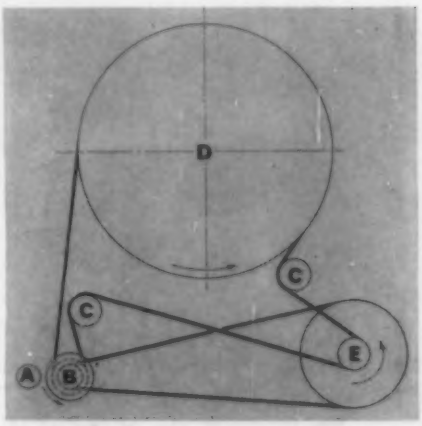
3 stage drive trimmed to 2 stages on combination washer-dryer

The Spring Division of Borg-Warner Corp. had developed a highly efficient drive for washer-dryer combinations using two of their patented clutches. However, large speed reductions were required which meant that a conventional three-stage reduction drive was necessary if V-Belts were used.

Dayton's Drive Engineering Service recommended that they try the Dayton Poly-V Belt, which uses smaller sheaves and shorter center distances, and provides greater gripping power in addition to noise and vibration freedom. To achieve maximum wrap on small sheaves, idlers were to be used which subjected the belts to an extreme reverse bend. Since the Poly-V Belt construction embodies a very thin cross section it lends itself to extreme reverse bending and long flex life.

Following Dayton's suggestion Borg-Warner engineers were able to design a compact, highly efficient drive of *only two stages* . . . using the outstanding Dayton Poly-V Belt.

Let Dayton's special Drive Engineering Service help you with your power transmission problems. Whether your design is still on the drawing board or in production write or call us for Dayton's Drive Engineering Service.



A—Solenoid: operates clutch. B—Unisprag * controllable clutch. C—Idlers. E—Tri-Cyl® one-way clutch.

Skillfully designed drive for automatic washer-dryer allows constant speed motor to deliver either spin or tumble speed at the flick of a solenoid . . . *with only 2 Poly-V Belts.*

*Reg. tradename, B/W Corp.

INDUSTRIAL DEPT

Dayton Industrial Products Co.

2001 Janice Avenue Melrose Park, Illinois *A Division of The Dayton Rubber Co.*

®Registered trademark of R/M Inc. Manufactured by Dayton Rubber under exclusive license of Raybestos-Manhattan, Inc.

"In the space available, this drive would have been impossible with V-belts," Roy Bowers, Project Engineer, Spring Div., Borg-Warner Corp., asserts. "Our basic problem *sounded* easy enough, just get from the motor to the drum, with an 8 to 1 reduction for spin speed, simply and economically. But with V-belts we couldn't get enough wrap on the small driver to do it in one stage. However, thanks to Dayton, the Poly-V Belt solved this problem for us."

Wherever greater power delivery is required within critical space limitations, Dayton Poly-V provides the answer with narrower sheaves, shorter centers, more speed ratios and up to *50% more power delivery in ⅔ the space.* It has an extremely long service life and will withstand operating conditions that soon destroy other types of belts.

HOW DO YOU FEEL ABOUT INDUSTRIAL DESIGNERS?

LIKE THIS? . . .

"Our big problem is letting the industrial designer get started before we know how the product will work, what materials are most economical and what our manufacturing techniques will be. When the designer gets in too soon, he is apt to waste our time designing things we can't make or which won't work."

DONALD L McFARLAND*

■ At some time in his career, every industrial designer has been face-to-face with both of these attitudes. Obviously, his job is a very difficult one when he encounters engineers who would subscribe to the first statement; conversely, he enjoys the relationship with those who share the second viewpoint. While it is true that those engineers who exhibit the more restrictive attitude have probably either been "burned" in the past or have never met an industrial designer who could speak their language, the basic difficulty stems from a lack of understanding.

If both the engineer and designer could keep one principle above all others in mind, at all times, half the battle would be won. Both have exactly the same objective—to produce the best possible product for their employer. The designer who stubbornly sticks to his impossible-to-make idea, and the engineer who refuses to alter a mechanical arrangement he personally likes are exhibiting immaturity which can only harm the product. Both the designer and the engineer should deliberately set their sights ahead.

Traditionally, however, it seems to be the designer who aims higher, and the engineer is cast in the villainous role of pulling him back to reality. However, in the pulling-back process, many engineers get overzealous and view this as a contest to see how little they can give. The designer, often sensing this, strives harder and becomes stubborn about things his common sense tells him to give up.

* Chairman, board of directors, American Society of Industrial Designers; B Sc in AeE; manager, Industrial Design Operation, Housewares Div, General Electric Co.

OR LIKE THIS? . . .

"We find the industrial designer very stimulating because he is constantly questioning our pet theories and proposing new ways of doing things. Some of his ideas are impractical, but most of the time he causes us to step further ahead than we would have of our own accord. He should be brought in at the very inception of a product."

If engineers and designers would stop considering themselves as antagonists and view themselves as protagonists instead, there would be more progress. Unfortunately, "protagonist" is defined as one who plays a leading part, and there can seldom be more than one leader. On the other hand, this suggests even more strongly that the engineer and designer should work together to be the leader in the product-development process. Any designer or engineer who has worked with a competent member of the other profession cannot doubt the other's capacity for making creative contributions.

But in today's "marketing revolution," many new functions have crept into the product-development process that sharply affect the work of engineers and designers, the only two functions that make a creative contribution to the product. With the excuse that "we can't afford to be wrong these days," management has supplemented its judgment with market research and product planning. Previously, the engineer and designer reigned supreme. The product was designed, put into production, and the sales department told to sell it. Now it has become fashionable to say, "We don't design what we want—rather we design what the customer wants." This sounds logical until the creative people start sitting back and waiting to be told what the customer wants.

With a competent product-planning department and a suitable market-research program, won't everything work out well in the end? Unfortunately, product planners don't plan products—only engineers and industrial designers can do this. The term "product planning" is a misnomer. It might better be called "product coordinating." When management relies primarily on such specialists for the innovations and ideas on which to base a product program, they short-circuit their best source of creative thinking.

As for market research, it can be a valuable tool to assist engineers and designers. But as is often the case, it can throw up so many warning flags that management is frightened away from real innovations. Despite the progress made in this field, the techniques of determining the acceptance of a new product or idea with which the customer is unfamiliar has not been adequately developed.

If you need proof that the technically creative people in industry have been swallowed up by the marketing philosophy and are abdicating their responsibility to develop new ideas, just read the results of a recent survey. This indicated that the most prolific source for new product ideas was the sales department. If this doesn't raise the hackles on the neck of any designer or engineer, he'd better stop taking tranquilizers.

However, before becoming too indignant, examine the marketplace and notice the tremendous "sameness" that is apparent in every field. This is the direct result of the sales approach to a new product—specifying your competitor's best features at a lower price. The sales department wouldn't have to resort to this uncreative approach if it was being fed what it likes better—really new products with sound, exclusive sales features.

This puts the burden right where it belongs—on engineers and industrial designers. The engineer might well study what one of his fellows (Myron Curtis, vice-president, engineering, Warner & Swasey Co) said at recent meeting of the American Society of Industrial Designers:

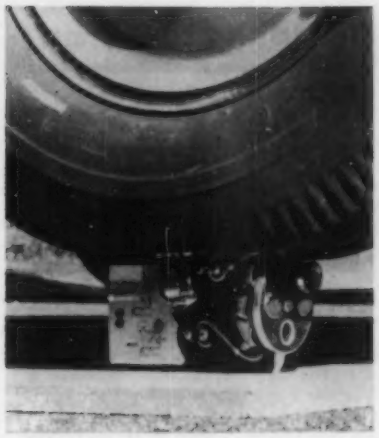
"The industrial designer is responsible for the working relationship, both physical and psychological, between the product and the human being." He added that every product has two functions, mechanical and human. The engineer is primarily responsible for the first and the industrial designer for the second. This thought should provide the basis for common understanding and a division of effort and responsibility.

The success of the product is the real goal. And both the designer and the engineer will be measured by that yardstick. Who contributed what, and who won the most battles will long have been forgotten once the product reaches the marketplace. The engineer and designer have more in common than they realize, and by working together they can increase their own stature while improving their employer's products. ■

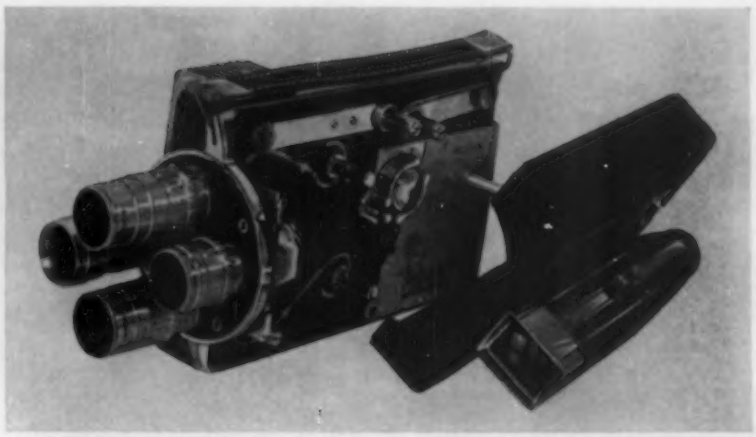
MAGNESIUM DIE CASTINGS MAKE NEW MOVIE CAMERA 31% LIGHTER, EASIER TO HANDLE

Using magnesium alloy in this Wittnauer "Cine-Twin" —that converts from camera to projector in 30 seconds—cut original design weight by almost one-third!

The case of the world's first movie camera-projector—the "Cine-Twin"—is made up of five magnesium precision die castings, produced to very close tolerances in Dow's Bay City, Michigan, die casting plant. By turning to magnesium castings for the case, Wittnauer gained not only substantial weight savings, but strength



Magnesium alloy die castings provide not only lightness for easy handling, but extreme strength and rigidity to withstand even the severe test shown above.



The Wittnauer "Cine-Twin" uses a total of five Dow magnesium precision die castings to form the cover. Total weight of the castings: 0.587 lb.

and rigidity to safeguard the precision mechanism inside.

In designing this new camera-projector, 4 pounds was selected as the ideal weight to aim for—light enough to handle, heavy enough to steady it in use. By substituting magnesium for the metal originally considered, the design weight was reduced by nearly 29 ounces per unit, a weight saving of 31%. As produced, the camera weighs *just 4 pounds.*

NEW DIE CASTING PLANT, ADVANCED METHODS . . .

New plant, advanced methods, latest equipment . . . here's a thumb-nail sketch of Dow's Bay City, Michigan, die casting plant for both aluminum and magnesium, which produces these castings for the Wittnauer division of Longines-Wittnauer. Here you'll find efficient plant layout, highly trained, experienced personnel, and modern quality control equipment that means economy through increased production. A complete range of equipment sizes and types is at hand, too. For example, a Dow developed device automatically meters magnesium to casting machines, substantially boosting production rates. One of the country's largest casting machines is at work here. And backing up this plant is 30 years of Dow experience in production die casting.

MORE DIE CAST PARTS PER POUND . . .

Magnesium gives you multiple production advantages. First, you get more die cast parts per pound of magnesium than from any other metal . . . as much as 50% more parts than aluminum, 4 times as many parts as from zinc. For example, from 6 pounds of magnesium you can die cast 6 parts, whereas from 6 pounds of aluminum you get only 4 parts, and from zinc only a part and a half!

Magnesium gives you another advantage . . . production rates 50% higher than aluminum in some instances. This is due to the lower heat content of magnesium which results in more rapid solidification in the die.

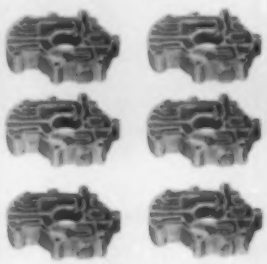
Other production cost factors come down, too. Magnesium machines faster and easier, reducing tool wear while it increases output substantially

* * *

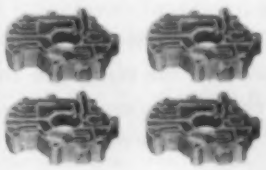
We've prepared a new die casting brochure which shows why our new die casting plant is your best source for light metal die castings. For a copy, contact the nearest Dow sales office, or write THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Department 1052DZ4-18.

FROM 6 POUNDS OF METAL:

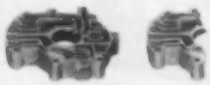
magnesium produces 6 die castings



aluminum, 4



zinc, 1½



See "The Dow Hour of Great Mysteries" on NBC-TV

DOW **THE DOW METAL PRODUCTS COMPANY**
Division of The Dow Chemical Company

Anchored by "Coining"

A casual glance at the fabricated piece illustrated here would not disclose anything unusual. Just a small dome of wire cloth—tungsten, by the way—fastened to a small copper ring.

But a careful examination will disclose something quite unique in the assembly...

Instead of being soldered or brazed to the underside of the ring after the section of cloth is inserted and folded over, individual wires are pressed or are 'coined' into the copper. A slight flowing of the copper anchors these wires firmly. Why go to all the trouble of developing this special method of assembly? Rigid specifications called for a *flat* contact surface on the underside of the ring, while at the same time carrying the mesh down through the hole in the ring, and crimping it over. The cloth couldn't be fastened on the upper side of the ring. It had to be underneath.

NEWARK for ACCURACY

Experienced specialists in our parts fabrication division devised this entire procedure—the way to anchor the cloth—the intensity of pressure—the machine to do the work. It's an excellent example of Newark ingenuity...a skill available to you in connection with your requirements of 'wire cloth parts.'

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

READER TO EDITOR

Texas Monorail

To the Editor:

This is to advice that Murel Goodell of Goodell Monorail of Houston was, up to October 1958, president of Monorail Inc and that any monorail developments created by him or other personnel of Monorail Inc during his tenure of office as president, are the confidential property of Monorail Inc. Specifically, the errors appearing in the article entitled "The Monorail Story," Jan 25, p 15 are as follows:

1. You state that Goodell Monorail of Houston has a prototype line running in Dallas. This is contrary to fact. The only line running in Dallas is at the Dallas Fair Ground, and is owned by Texas Skyways Inc, a subsidiary of Monorail Inc of Houston, and was developed by Monorail Inc of Houston.

2. You state that the design appearing at the upper lefthand corner of page 16 was designed by Murel Goodell of Houston. This design was developed by personnel of Monorail Inc of Houston, and is the property of Monorail Inc of Houston.

3. Under the subheading "Secrecy Shrouds Texan's Project X" on page 16 of your article, you again state that Murel Goodell has a monorail running in Dallas, contrary to fact.

—Sixten Holmquist, *president*
Monorail Inc

The Privileged Group

To the Editor:

In an article that appeared in the January 25 issue, p 4 under "Sidelights," you paraphrased one of the major reasons our country finds itself in a position of internal conflict among military branches of the service, the various departments of our executive government, our missile and aircraft industries and many other forms of industry and business. To quote from your article: ". . . we are not very sympathetic to the practice of setting up a privileged group with express orders to read the scientific journals for ideas, implying that the rest of the staff can jolly well grind out the eight-hours-a-day product problems."

As I see it, you have at least three choices in selecting a method of satisfying your egoism: (1) You could approach management and explain in detail that a program, such as you so vehemently oppose, is not practical and serves no worthwhile purpose. (2) You could propose your own solution to management's attempt to keep their engineers informed about new developments, many of which are presented in the scientific journals. (3) You could "jolly well" quit your job and take a position with a company that shares your feelings. Then you wouldn't have to suffer the ignominious position of being a part of an underprivileged group.

I do not mean to imply that constructive criticism should be censured, but in these days of charges and countercharges and editorials decrying the supposed fact

that our national security is in jeopardy, it seems that people would do their own jobs to the best of their ability and try to help others with constructive criticism. Accept new ideas even at the expense of a slightly hurt ego and contribute ideas to co-workers, management and the government, which will aid us all in solving the many complex problems facing our country today. —WILLIAM A GANDY

Sperry Farragut Co, Bristol, Tenn

• Our criticism was aimed at two implications: the first is the attitude, apparently shared by many executives, that they can buy, sell, and cultivate brainpower as you would a vegetable garden. Today everybody lauds creativity, but they accept it only when it is clothed in a neat blue suit and not really too far advanced.

Our second objection is that everybody should have time to read the literature, not just a few. It's an earmark of the professional that he never stops learning—and a company shows very little respect for its engineers when it puts blinders on them and hooks them to a plow. I submit that it is precisely this arbitrary limitation of view that causes the interservice rivalry and duplication of effort wasting so much of our country's time and money.—RMK

COMING EVENTS

APRIL

19-21 . . . . American Society of Lubrication Engineers, Annual Meeting and Exhibit, Netherlands-Hilton Hotel, Cincinnati.

20-22 . . . . Institute of Radio Engineers, 1960 Southwestern Conference and Electronics Show, Shamrock-Hilton Hotel, Houston.

21-28 . . . . American Society of Tool and Manufacturing Engineers, 1960 Engineering Conference and Exhibit, Detroit Artillery Armory, Sheraton and Statler Hotels, Detroit.

25-29 . . . . American Society of Mechanical Engineers, American Welding Society, Annual Meeting and Welding Exposition, Biltmore Hotel, Los Angeles.

26-27 . . . . Westinghouse Machine Tool Forum, Conrad Hilton Hotel, Pittsburgh.

28-29 . . . . Illinois Institute of Technology, Seminar on Aids in Design Room Management, Urbana, Ill.

MAY

8-11 . . . . National Fluid Power Association, 1960 Spring Meeting, Grand Hotel, Point Clear, Ala.

9-13 . . . . Society of Photographic Scientists and Engineers, 1960 Annual Conference, Miramar Hotel, Los Angeles.

9-13 . . . . American Society for Metals, Southwestern Metal Show, State Fair Park, Dallas.

Giants of American instrument industry, including such firms as . . .

- Bulova Research & Development Laboratories, Inc.
- Eclipse Pioneer, Division of Bendix Aviation Corp.
- Federal Telecommunication Laboratories, Inc.
- General Electric Co.
- Sperry Gyroscope Co.

and many others think of CHATILLON, when instrument design calls for the "world's most accurate spring".

CHATILLON . . . the leading manufacturer of precision springs is particularly proud of the improved performance record of instruments using the noteworthy CHATILLON developed temperature-compensated alloy "Iso-Elastic". The hysteresis error of this remarkable spring is less than .05% of deflection. Drift does not exceed .02% of deflection in 5 minutes. These characteristics plus temperature compensation insure the ultimate in precision spring production.

CHATILLON makes Extension, Spiral, Torsion, Compression and Form Springs of Iso-Elastic material, as well as springs of all conventional alloys.

To find out how "the World's Most Accurate Spring" can better your product and for engineering bulletins, write CHATILLON SPRING DIVISION.

*U.S.A. Pat. No. 2174171

JOHN CHATILLON & SONS
85 CLIFF STREET, NEW YORK 38, N.Y.
Manufacturers of Scales, Force Measuring Instruments and Precision Springs Since 1835

CIRCLE 29 ON READER SERVICE CARD

NOW AVAILABLE!

P-K® SOCKET SCREWS WITH LONG-LOK® INSERTS

Provides high resistance to shock and vibration.

Assures superior thread engagement and locking force.

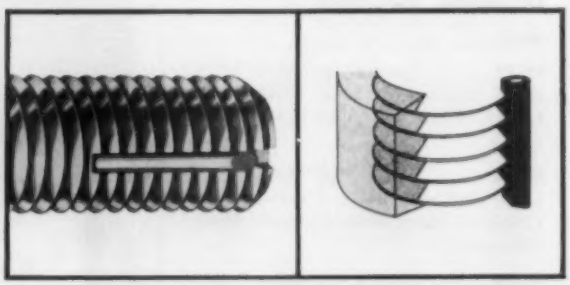
Permits high reusability.

Eliminates lock washers and safety wire.

WHAT IS LONG-LOK?

Long-Lok is an insert which becomes an integral part of the P-K Socket Screw in which it is used. A root-deep axial slot is milled into the external threads of any of the various types of P-K Socket Screws and permanently filled with a specific material engineered for the design application. In use, the insert provides triple locking action: (a) axial tolerance is taken up by the resilient insert material, causing metal-to-metal "drag", (b) radial tolerance is taken up because the side opposite the insert is forced into close contact for additional metal-to-metal "drag", and (c) torsional resistance of the insert itself.

The fastener is easily inserted and started because of the tapered end of the insert. The length of the insert assures full engagement of the locking material and a radial load on mated threads.



In locking and anchoring applications, the insert assures a radial load on mated threads which results in increased contact friction at the thread flanks. Under operating conditions, the friction then prevents relative motion between the mating threaded parts. In sealing applications, the insert is selected and processed to result in a dam which prevents the flow of gas or liquid along the thread helix. Axial of a fluid or gas is prevented by a uniform annular flank-to-flank contact of the mating thread pitches.

HERE ARE SOME OF THE ADVANTAGES!

P-K Socket Screws with Long-Lok Inserts speed-up and improve reliability of assembly operations. The P-K Socket Screw with Long-Lok is not dependent upon seating operations, locking securely wherever installation torque stops. Long-Lok inserts span temperature ranges from –320°F to +1200°F as required; pass through normal clearance hole with ease and install easily because torque forces build up smoothly and gradually all the way.

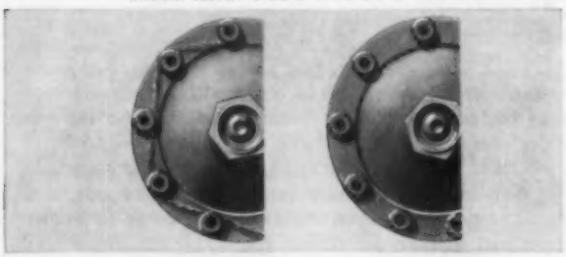
The Long-Lok insert does not protrude, thus P-K Socket Screws with Long-Lok inserts pass through normal clearance holes with finger pressure. No special clearance holes are required. Normal handling or installation will not dislodge inserts.

P-K Socket Screws with Long-Lok inserts make possible a long range of adjustment, and because of the extremely low "cold flow" and exceptional "memory" of the insert material, insure a high degree of reusability. Insert material does not project beyond the basic diameter of the fastener and the slot does not present an abrupt change of section to operating loads. What's more, the small cross sectional area of the insert has no effect upon fatigue strength and does not reduce basic rated tensile strength of the unit.

WHERE SHOULD LONG-LOK BE USED?

In industrial and consumer products—tools, machines, appliances—wherever vibration is present—wherever adjustment may be required—wherever re-use is a factor—wherever the needs of quality control in production are exacting . . . P-K Long-Lok fasteners may be the right answer. In the electronics industry, in engines, hydraulics, valves, optical instruments—even in guided missiles—Long-Lok is building an enviable reputation for reliability.

TIME AND COST REDUCTION



Critical weight and needless man-hours of assembly time can be saved through the use of P-K Socket Screws with Long-Lok inserts. The fasteners are heat, impact, shock and vibration resistant. They completely eliminate the need for intricate and costly safety-wire installations.

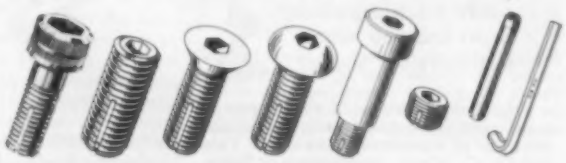
In the aircraft industry, fasteners with Long-Lok inserts are an exciting advance—opening up new, faster, safer design opportunities—doing away with costly, intricate safety-wiring operations—resulting in fastenings that stay tight and secure under punishing vibration—under every environmental attack. Long-Lok fasteners are already in use in supersonic applications and meet the requirements of #MIL F 18240A (ASG) and NAS1081 specifications.

In the automotive industry, P-K Socket Screws with Long-Lok inserts will meet every requirement for efficiency and reliability. As an adjustment screw, this new fastener can offer superior performance and in many cases the efficiency of the insert can act as a barrier against fluid leakage, eliminating the need for messy sealing compounds.

HOW IS THE LONG-LOK FURNISHED?

Parker-Kalon Socket Screws with Long-Lok inserts are available in socket head cap screws, set screws, flat head, button head, shoulder screws and pipe plugs. They will be stocked by your P-K Distributor in a range of popular sizes with Polycap (green) inserts. Polycap is a nylon type polymer capable of performing within a temperature range of −120°F to +250°F and recommended for general applications, thread-sealing applications and applications requiring frequent adjustment.

On order, Parker-Kalon will supply Socket Screws with Long-Lok BLUE-KEL-F® inserts, a thermoplastic with zero water absorption for −120F° to −320°F, and for +250°F to +390°F. For use where temperature requirements range between +400°F and +1200°F, Parker-Kalon will furnish Socket Screws with Long-Lok metallic inserts.



A COMPLETE LINE

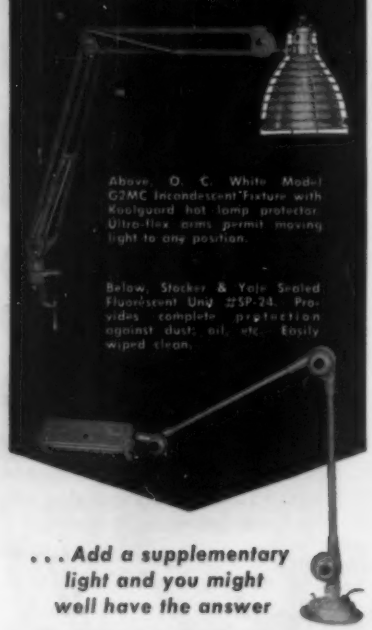
Parker-Kalon offers a complete line of Socket Head Cap Screws, Shoulder Screws, Button Heads, Flat Heads, Set Screws, Hex Keys and Key Kits, Dowel Pins and Pipe Plugs, as well as the P-K Pre-Lode (1960 Series) Socket Head Cap Screw and the revolutionary new P-K W-Point Socket Set Screw.

SAMPLES AND TECHNICAL DATA MAY BE OBTAINED FROM YOUR P-K INDUSTRIAL DISTRIBUTOR, OR WRITE DIRECTLY TO PARKER-KALON FOR BULLETIN NO. 862.

PARKER-KALON®
Socket Screws

PARKER-KALON, a division of General American Transportation Corporation, Clifton, New Jersey · Offices and warehouses in Chicago and Los Angeles.

How to improve equipment designs



Above, O. C. White Model G2MC Incandescent Fixture with Koolguard hot lamp protector. Ultra-flex arms permit moving light to any position.

Below, Stocker & Yale Sealed Fluorescent Unit #SP-24. Provides complete protection against dust, oil, etc. Easily wiped clean.

. . . Add a supplementary light and you might well have the answer

Proper illumination of work areas is a necessity if operators are to get the most out of equipment. Stocker & Yale and O. C. White supplementary lights give the illumination they need . . . clear, concentrated, high level, glare-free. And, too, these lights add a profitable selling feature at very little extra cost.

There's a Stocker & Yale or O. C. White Light just right for every requirement: standard or special • fluorescent or incandescent • choice of arms, bases, switches, ballasts, reflectors • available with optically ground magnifiers • sealed units for protection against dust, oil, etc. • arms easily adjustable • advanced electrical and mechanical designs • high quality construction and manufacture.

Engineering Assistance **— on special applications, or where you have a problem, let our engineers provide the answers.**

O. C. White Lights distributed nationally by O. C. White Sales Co., Marblehead, Mass.

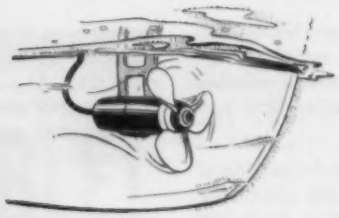
STOCKER & YALE

Lite-Mite Lights — O. C. White Lights

Want Details? ☐ Catalog of standard lights ☐ Special requirement outlined in letter

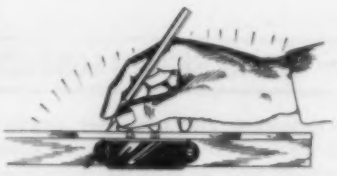
Just clip to your letterhead, sign and mail to: STOCKER & YALE, INC., 46 Green St., Marblehead, Mass.

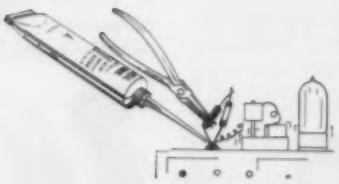
WHY DON'T THEY R&D . . ?



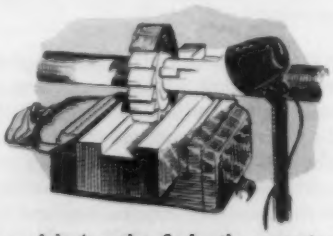
. . . a small, turbine-driven generator for outboard-powered boats and sailing craft. Water moving past the boat would turn a small turbine to generate the low-voltage power needed for running lights, radio and other accessories. Power could be consumed directly, or stored in wet-cell batteries. Turbine and generator, made as a single unit (suitably waterproofed), could be attached to the side of the boat below the waterline when power was needed. —A Esposito

. . . electroluminescent paneling built into the top surface of drafting tables. The soft light would illuminate the drafting surface for normal drafting as well as for tracing. It would reduce eyestrain and be cooler and less bulky than a light box or tracing table illuminated by fluorescent lamps. —W Hoffman





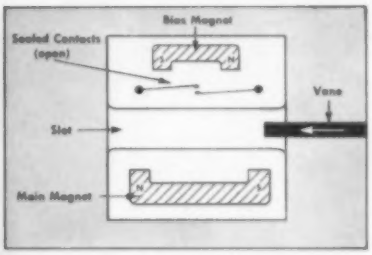
. . . cold solder for making electrical joints quickly, without a soldering iron. It would be useful for many household electrical repairs and for do-it-yourself electronic projects: Just squeeze a small amount from the tube onto the joint and let harden. Might also replace conventional solder for assembly of delicate components (transistors, diodes, etc.) that can be damaged by heat conducted through leads. Most of the cold solders now available do not have the low resistance needed for electrical work, are too brittle and do not adhere well to metal. For the most part, they are simply a variation of the cellulose household cements that harden by evaporation of a volatile thinner. A solder made from a mixture of epoxy resin and powdered metal could probably be made to give necessary physical properties. Epoxies are strong, reasonably flexible, adhere well to metal. Also, they do not shrink when they set; they harden by chemical action, not evaporation. —L van Zeyl



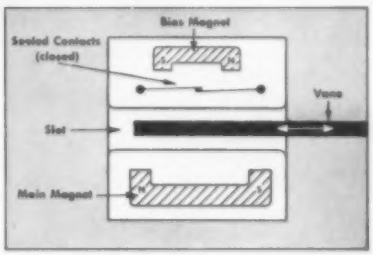
. . . a strobe-light attachment for machine tools such as lathes, drill presses and milling machines to permit the operator to inspect the rotating work or tool. Timing could be quite simple if the light were triggered to flash once for each revolution of the machine. By advancing or delaying the flash, the operator could observe the revolving part in any desired position. —R Marie

Have you a problem, based on known scientific principles, which seems to have an answer somewhere within the limits of present technology? To inspire inventors along worthwhile paths, PRODUCT ENGINEERING invites you to trade such problems with fellow readers who have a fresh viewpoint or more time to experiment. We pay $10 for each one accepted.

NEW vane-operated limit switch helps industry solve major electrical problem: limit switch life



On normally open form, bias and main magnet flux are balanced at the switch, causing it to remain open. As vane enters the slot, flux of the main magnet is shunted to the lower reluctance path offered by the magnetic material in the vane.



As vane passes the center of the switch, enough flux shunts from the main magnet to cause the flux of the bias magnet to close the switch. Withdrawing vane from the slot reverses the conditions and causes the switch to reopen.

GENERAL ELECTRIC'S ENCAPSULATED DESIGN SEALS OUT CONTAMINANTS; HAS NO ARMS, LEVERS, OR SHAFTS

General Electric's new vane-operated limit switch design surmounts most of the operating problems that cause failure in today's conventional limit switches. The unique new limit switch performs the position-detection function of conventional switches and *eliminates physical contact with the moving object*. It has no shafts or arms to fail, no sliding or rotating parts to wear, no shaft seals to leak.

This means that the operating life of the vane-operated limit switch is not affected by such tough application requirements as frequent operation; hammering of lever arms and mechanisms; lever arm "snapback"; mechanical wear; and splashing and spraying of coolants, lubricants, and other contaminants.

REASONS FOR LONGER LIFE

Contributing to the extremely long life of the new device is the encapsulation of all internal components in a cast aluminum enclosure. This means liquids, dirt, or metal chips cannot enter the switch mechanism and cause operational failure.

In addition, the only moving parts in the new design are magnetic reed contacts hermetically sealed in an inert gas. Thus, switch life is determined almost solely by contact load. When used with small a-c relays, such as the G-E CR2790 general purpose type, the expected operating life of the switch is from 30 to 50 million operations. It is capable of over 250 million operations when operating General Electric static control circuits.

The inherently longer life of the new vane-operated limit switch results in savings from greatly reduced maintenance and replacement expense and less downtime. And the new switch costs about two-thirds less than proximity switches, making it only slightly higher in price than a conventional limit switch.

HOW IT WORKS

The vane-operated limit switch is energized by passage of a separate steel vane through a recessed slot in the switch (see illustrations at right). The vane is attached to the mechanism to be controlled. As the vane passes through the slot, it changes the balance of the magnetic field, causing the contacts to operate. The contacts are hermetically sealed in an inert gas to prolong life.

The new switch is easy to install. Front- or top-operated forms are available to control linear or rotary travel. In addition, the base plate can be rotated 90° to provide mounting flexibility. Both normally open and normally closed forms are available with or without an indicating light. The new limit switch is 25 percent smaller than previous models, and it requires no separate power supply or amplifier.

The switch can detect very high speeds of vane travel without detrimental effects such as arm or mechanism wear or breakage. The switch also offers excellent accuracy and response time. Providing the path of the vane through the slot is constant, trip point repeatability is constant within plus or minus 0.0025 inch. The switch response time is approximately one millisecond.

MEASURABLE ADVANTAGES

Vane-operated limit switches hold significant and measurable operating advantages over conventional limit switches. These advantages can be measured by the maintenance and replacement savings they can produce, and deserve serious consideration on limit switch applications.

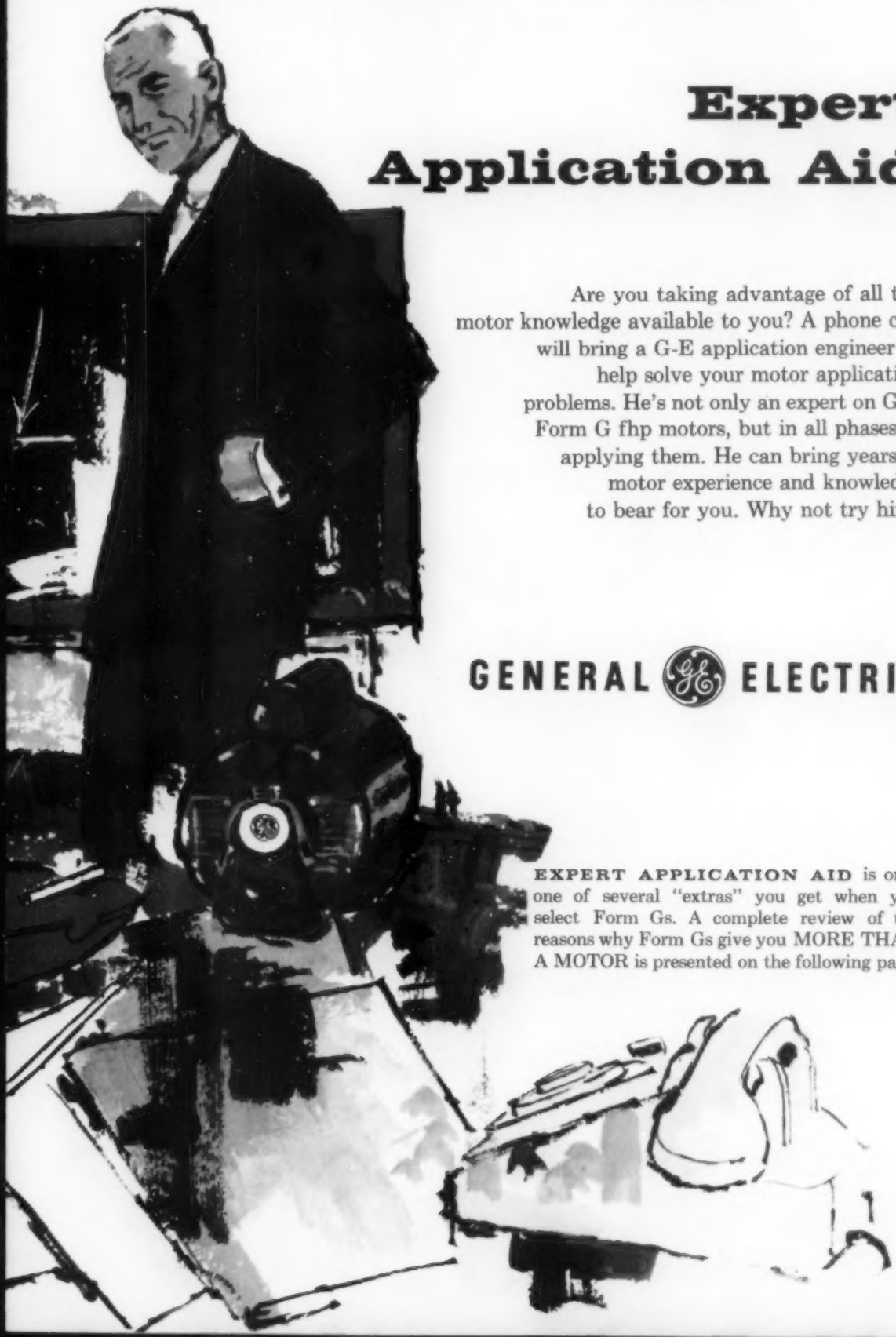
For more information contact your G-E sales office or request bulletin GEA-6995 from General Electric Company, Schenectady, N. Y. 811-8

GENERAL ELECTRIC

You get
MEASURABLE ADVANTAGES
with General Electric control.

You get MORE THAN A MOTOR with

General Electric's Form G...for example...



Expert Application Aid

Are you taking advantage of all the motor knowledge available to you? A phone call will bring a G-E application engineer to help solve your motor application problems. He's not only an expert on G-E Form G fhp motors, but in all phases of applying them. He can bring years of motor experience and knowledge to bear for you. Why not try him?

GENERAL ELECTRIC

EXPERT APPLICATION AID is only one of several "extras" you get when you select Form Gs. A complete review of the reasons why Form Gs give you MORE THAN A MOTOR is presented on the following page.

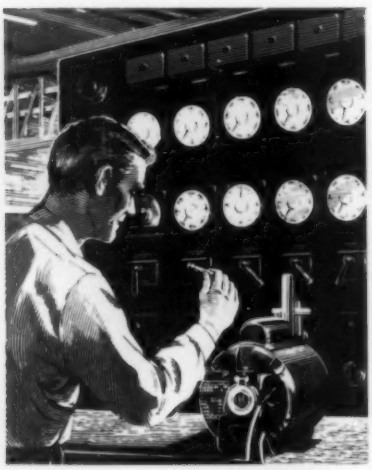
These unmatched extras make G.E.'s Form G

MORE THAN A MOTOR

YEARS-AHEAD DESIGN LEADERSHIP—General Electric's year-in year-out leadership in fractional horsepower motor design and innovation helps meet your changing product demands; helps keep you "out front".

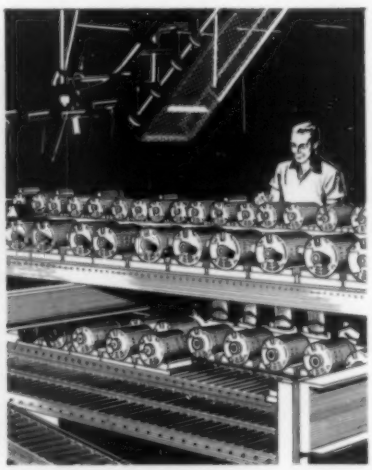
FAST, LOCAL SERVICE—A nationwide network of Electric Motor Service Stations, kept up-to-date on latest motor techniques by twenty traveling motor specialists, assures fast, local motor repair or replacement.

DESIGN VERSATILITY—Form G fhp motors offer amazing versatility and design freedom for incorporation into your product. Whatever your product requirements, there's a G-E Form G fhp motor to meet them.



QUALITY CONTROL—"Individualized" quality control assures consistently high quality. Every Form G motor is thoroughly tested at all stages of production for top performance and long-life characteristics.

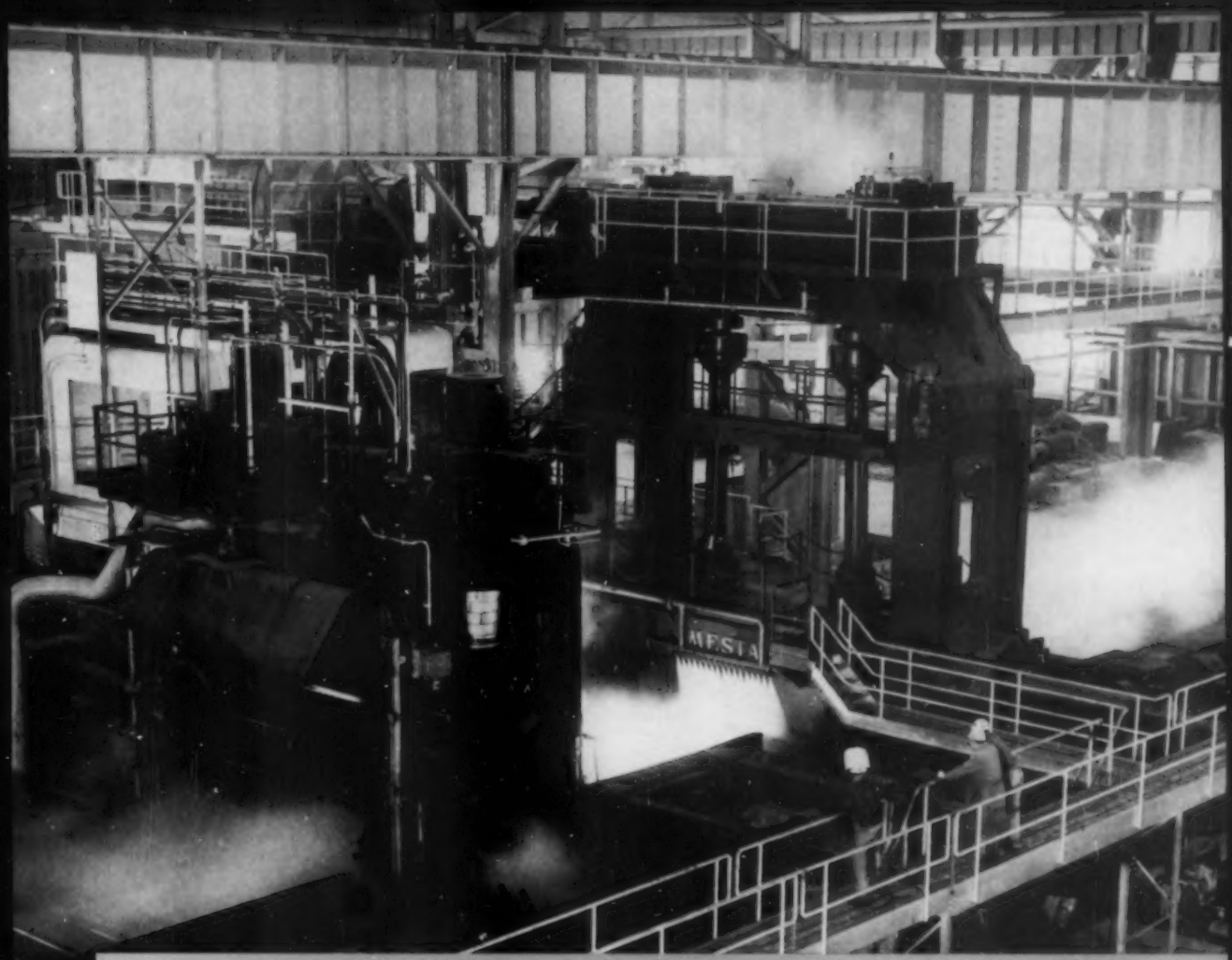
EASE OF ASSEMBLY—Compact G-E Form G fractional horsepower motors can be mounted and hooked up in a matter of seconds; offer assembly-line savings in time and money; cost less to ship or handle.



DELIVERY PERFORMANCE—Delivery you can count on is made possible by General Electric's multi-plant manufacturing facilities. The motors you need are available when you need them—where you need them.

Make sure you get MORE THAN A MOTOR when you select fhp drives for your product . . . choose General Electric Form G motors, available in NEMA 48 and 56 frames. For more information, contact your nearby General Electric Apparatus Sales Office or write General Electric Co., Section 702-107, Schenectady 5, N. Y.

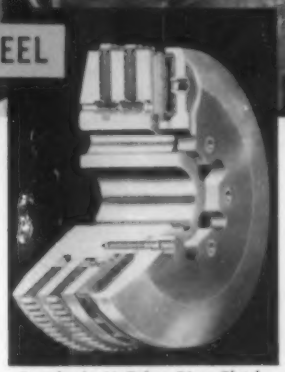
GENERAL ELECTRIC



140 INCH MESTA SLABBING MILL WITH COMPACT, POWERFUL WICHITA CLUTCHES ON SCREW-DOWN SETS NEW WORLD STANDARD FOR LUKENS STEEL

Outstanding feature of the horizontal mill is the screw-down drive with unique Wichita Clutches.

In place of conventional magnetic or mechanical clutches, are a pair of Wichita Air-Tube Disc Clutches . . . transmitting torques of 9,000 ft.-lbs. to run the screws down. The clutches are normally open and do not rely on electric current for normal mill operation. In addition, they are more compact than conventional clutches and offer many safety features.



Standard Air-Tube Disc Clutch

For difficult or unusual clutching or braking problems it will pay you to call a Wichita Clutch engineer.

Contact your nearest Wichita Engineer.

Clutch & Control Engineering Co., Livonia, Mich.
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co., Avon, Conn., Philadelphia 44, Pa., and New York, N. Y.
Frank W. Yarline Co., Chicago, Illinois
Larry W. McDowell, Long Beach, California
Andrew T. Lobel, Denver, Colorado
Robert R. King Co., Cleveland, Ohio
Norman Williams, Houston, Texas
Allied Transmission Equipment Co., Kansas City 8, Missouri
Donald E. Harman, Dallas, Texas
C. Arthur Weaver, Richmond, Virginia
Malcolm S. Cone, Memphis, Tennessee
Dominion Power Press Equipment, Ltd., Burlington, Ontario, Canada
R. E. Kunz, Seattle 4, Wash.
Norman Rupp Co., Portland 4, Ore.
Bates Sales Co., St. Louis 1, Mo.

WICHITA CLUTCH COMPANY, INC.

CIRCLE 37 ON READER SERVICE CARD

Belleville

Compression

Conical

Die

Discs

Drawbar

Energy Cartridge

Extension

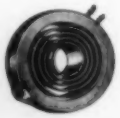
Flat

Garter

Hairsprings

Helical

Hourglass



Power

Spiral

Starter

Swivel End

Torsion

Valve

Variable Pitch

Volute

springs

and other things

custom-made to quality standards

Answer your "where to get it" questions– by calling on the versatile experience represented by these typical springs and stamped parts. Here is unusual ability to analyze your part from both design and production efficiency and to make cost-saving contributions where possible. Whether your requirements are large or small, routine or extreme precision, you'll get a better brand of service and quality from the best springmakers in the business.

Send for "Pocket Guide to Springs and Other Things" —a quick picture of our products and services.

Assemblies

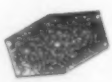
Catches

Clamps

Clips

Electronic Coils

Fasteners



Plates

Retainers

Stampings

Terminals

Washers

Wire Forms

6003

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
F. N. Manross and Sons Division, Bristol, Conn.
Dunbar Brothers Division, Bristol, Conn.
Wallace Barnes Steel Division, Bristol, Conn.
Raymond Manufacturing Division, Corry, Penna.
Ohio Division, Dayton, Ohio
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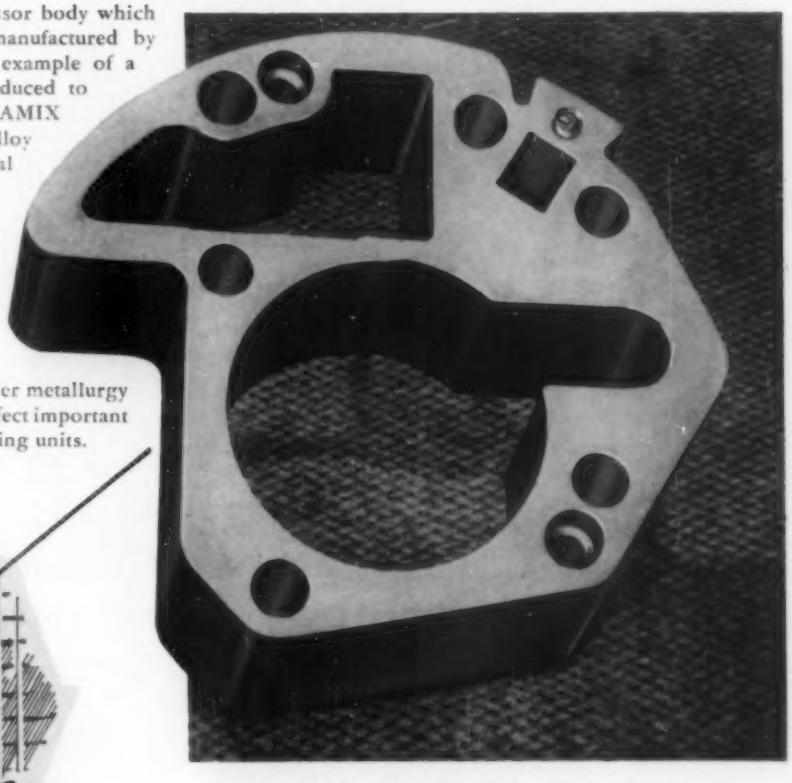
Gibson Division, Mattoon, Ill.
Milwaukee Division, Milwaukee, Wis.
Seaboard Pacific Division, Gardena, Calif.

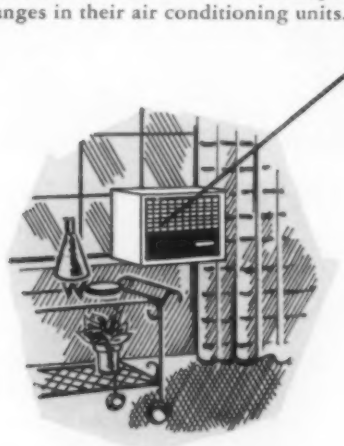
Canadian Subsidiary: Wallace Barnes Co., Ltd., Hamilton, Ont. and Montreal, Que. Puerto Rican Subsidiary: Associated Spring of Puerto Rico, Inc., Carolina, P.R.

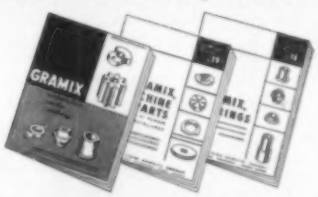
GRAMIX® COMPRESSOR BODY IS VITAL PART IN GENERAL ELECTRIC AIR CONDITIONER . . . this GRAMIX part is a new concept in powder metallurgy techniques . . . engineered to meet requirements of GENERAL ELECTRIC's new compressor design

This large, complex shaped compressor body which is employed in air conditioners manufactured by General Electric is an outstanding example of a GRAMIX part engineered and produced to exacting specifications. As in all GRAMIX products of powder metallurgy, the alloy was created to meet exacting physical properties required in this particular application. Correct briquetting, controlled sintering procedures, precise finishing operations and rigid quality control throughout the manufacturing process assures General Electric uniform, dependable GRAMIX parts. The production of this body as a product of powder metallurgy has also enabled General Electric to effect important design changes in their air conditioning units.



This part is shown full size. Actual weight: 2¼ lbs.





Write today for these helpful engineering manuals. Engineering Bulletin No. 18 covers design and metallurgical requirements and alloy selection of GRAMIX bearings. No. 19 contains facts about GRAMIX Machine Parts and No. 21 contains general information on GRAMIX products from Powder Metallurgy. Get your copies now.

X-274-1

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 1, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

Fabricating parts from long lengths of "premachined" shapes reduces machining, scrap, and finishing

The lock components shown above are typical of some 20 different precision brass parts which Welch, Inc., Waukegan, Ill., makes for its broad line of locks and latches, from Anaconda extruded shapes.

Welch works closely with Anaconda specialists from early design stages. New lock mechanisms are built around parts which can be cut by a metal slitting saw from long lengths of extruded shapes with minimum subsequent machining and scrap. The use of bar stock is never considered when there is the slightest possibility of designing savings into a part by means of a brass extrusion.

Superior quality, too. Parts made from extruded shapes are characterized by their strong, homogeneous, wrought-metal structure. And the smooth, extruded surfaces reduce many finishing operations.

More and more manufacturers are cutting fabricating costs *and* maintaining quality by using these preformed or, in effect, "premachined" shapes. For imaginative and practical help in adapting extruded shapes to the economical production of intricate parts, call your Anaconda representative or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

Extruded Shapes • Special-Shape Tubes • Die-Pressed Forgings

ANACONDA®

products made by The American Brass Company

first in silicones

Dow Corning

SILICONE NEWS

for design and development engineers • No. 73

Preventive Measure

The newest addition to Dow Corning's line of silicone antifoamers, Antifoam C, should be a practical aid to designers — particularly designers of appliances, liquid food dispensing or vending machines, and industrial equipment that handle, process or package materials that foam.

All the ingredients of Antifoam C, at the prescribed level, are sanctioned by the Federal Food and Drug Administration or are considered "generally recognized as safe" (See the Federal Register, Volume 25, Number 22, February 2, 1960, pages 866 and 881).

The use of Antifoam C in nonstandardized foods is permissible in amounts up to 33.3 parts per million under the Federal Food, Drug and Cosmetic Act as amended by the Food Additives Amendment of 1958.

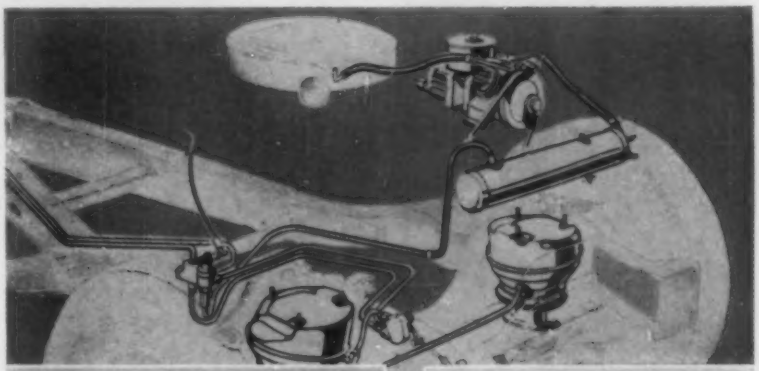
Extensive field testing of Dow Corning Antifoam C points to its practicality for a variety of nonfood industrial applications including vat dyeing of textiles, processing of paints, insecticides, latices and intermediates, and manufacturing petrochemical products, adhesives, antibiotics and asphalt.

For more information about this new defoamer, Antifoam C, and other silicone antifoam agents that can help you in design or in production, circle ..... *No. 241*

SEE US AT BOOTH 1915

Make it a "must" to stop by . . . for a quick check of the latest developments in the rapidly moving field of silicones . . . .

1960 DESIGN ENGINEERING SHOW — NEW YORK COLISEUM — MAY 23-27



SEALS STAY FLEXIBLE

Retaining hot fluids or oils is easy . . . with seals made of Silastic®, the Dow Corning silicone rubber!

The popular automotive device pictured above is both pump and air compressor. Part of the unit pumps hydraulic fluid for the power steering system, the other half compresses air for the pneumatic suspension system.

Because both units operate from the same drive shaft, it is necessary to have a positive seal that prevents pump fluid from leaking along the shaft into the air compressor . . . . . that remains flexible from —30 to 350 F and maintains a good seal in spite of temperature variations and possible shaft wobble or misalignment.

Company engineers specify seals made of Silastic because they most effectively meet these requirements. The Silastic seals maintain a tight fit despite rpm's up to 6,000 and operating temperature up to 350 F. Since it is actually suitable for service from —130 to 500 F, Silastic easily meets the flexibility at —30 F requirement.

Silastic has earned its keep over and over as a gasketing and sealing material in the aircraft, automotive, appliance, electrical and process industries. You'll find it's profitable to consider Silastic whenever you have need of a flexible, durable sealing or gasketing material that must remain serviceable over a wide temperature span and in adverse environments. *No. 242*

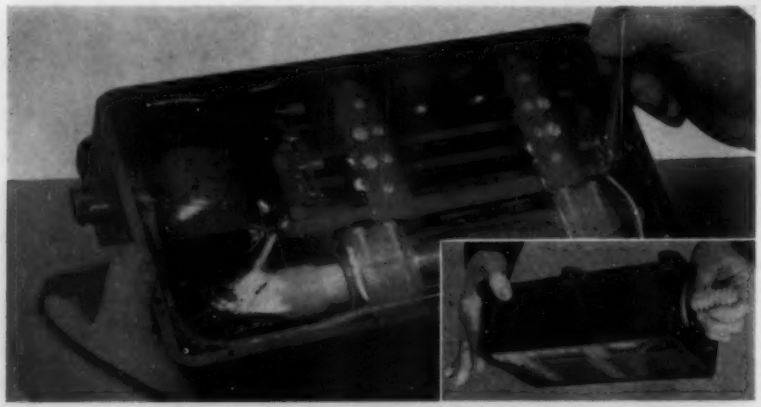
Effect of Heat Aging on Resiliency of Silastic and a Heat-Stable Organic Rubber

Temperature	Hours	Resiliency[1] Silastic 50	Organic
300 F	0	OK	OK
	96	OK	Broke
	1344	OK	——
	6384	OK	——
392 F	0	OK	OK
	19	OK	Broke
	1344	OK	——
	5040	OK	——
480 F	0	OK	OK
	8	OK	Broke
	168	OK	——
	1344	OK	——

[1] As indicated by ability to take an 180 degree bend over 3/8" mandrel without breaking.

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE OR REFERENCE NUMBER ON READER SERVICE CARD

MORE



NEW AID TO MINIATURIZATION

New potting techniques developed by engineers at CBS Laboratories, a division of Columbia Broadcasting System, Inc., Stamford, Conn., capitalize on the properties of Dow Corning Dielectric Gel . . . result in substantial reductions in size and weight of airborne components of the "Photoscan" all electronic, visual reconnaissance system.

Supplied as a fluid to facilitate filling and potting assemblies, Dielectric Gel sets up to a pliable, transparent gel of high dielectric strength, moisture resistance and thermal stability. The gelled mass exerts virtually no stress on components; has excellent adhesion; is not displaced if vibrated or inverted. CBS engineers found that Dow Corning Dielectric Gel supplied the many miniaturization and reliability advantages they sought for Photoscan's high voltage power supply.

Dielectric Gel reduces bulk by permitting high voltage components to be spaced less than ¼ inch apart without danger of arcing . . . enabled the power supply, capable of regulated voltage outputs of 1,000 and 25,000 volts, to meet stringent reliability requirements. It further reduced bulk by eliminating the elaborate bellows and seals necessary when using a liquid dielectric.

Other advantages: Dow Corning Dielectric Gel effectively cushions components against shock and vibration, permits instrument and visual checking of the power supplies, and greatly simplifies production and servicing . . . heals itself when probes are removed, leaves no voids. *No. 243*

TYPICAL PROPERTIES OF CURED DIELECTRIC GEL

Color	Water	White
Specific Gravity at 25 C		0.970
Electric Strength*, volts per mil		800
	23 C	150 C
Dielectric Constant 100 cps - 0.1 Mcs	3.0	2.6
Volume Resistivity†, ohm-cm.	1×10^{15}	1×10^{14}

* 60 cycles, rapid rise, 0.020 inch-spacing of 0.5 inch-diameter spherical electrodes.

† Using 54 mmfd fixed air capacitor, Cardwell type, ER-50-FS as electrodes, ASTM D150-54T and D1169-52T.

NEW ENGINEERING GUIDE

This recently published reference provides pertinent properties, data, and application information about the various silicones specified and used by design and production engineers in all fields. A comprehensive 16-page brochure includes concisely packaged information on silicone fluids, lubricants, resins, adhesives, varnishes, dielectrics, rubbers, water repellents, textile finishes, leather treatments, and other silicone products that offer practical solutions to a great variety of design problems. To obtain your copy, circle ..... *No. 244*

new literature and technical data on silicones

Tackles Many Insulation Jobs — Today's electrical equipment requires insulation with endurance. A reprint from Power lists the many types of electrical equipment which perform better and last longer as a result of the use of silicone insulation . . . points up the benefits to be realized in industrial applications. *No. 245*

To Design For Better Performance — Silicone fluids have proved themselves essential in numerous modern designs . . . of such diverse equipment as damping devices, liquid springs, fluid couplings, and hydraulic power transmission units. An 8-page brochure includes graphs, tables, illustrations, and to-the-point copy that give a complete reference review of Dow Corning silicone fluids — cites how exceptional thermal stability and other outstanding characteristics are used advantageously to meet a variety of application requirements. *No. 246*

Effect of High Temperature and Nuclear Radiation on Silicone Insulation Systems is detailed in an article reprint from Electrical Manufacturing. An intensive evaluation program on several silicone insulating systems has yielded realistic performance data that are presented in comprehensive, easy-to-study tables and graphs. A practical analysis of a thorough study. *No. 247*

The Big Picture — An article published in Yale Scientific gives a full, comprehensive picture of the structure and synthesis, uses and prospects of Dow Corning Silicones. Clearly describes how the earth's two most abundant elements are combined to produce vital design keys for many applications. This interesting article also explains how silicone materials are either aids to processing or an integral part of products in nearly every industry. *No. 248*

Tapes that Stick — Dow Corning silicone pressure sensitive adhesives make tapes stick to anything. They help achieve serviceability over a wide range of temperatures, resistance to oxidation, weathering, corrosive chemicals, and retention of good dielectric properties. For information on the properties of tapes made with Dow Corning silicone adhesives, and their applications, circle . . . . . *No. 249*

Dow Corning Corporation, Dept. 8694, Midland, Michigan

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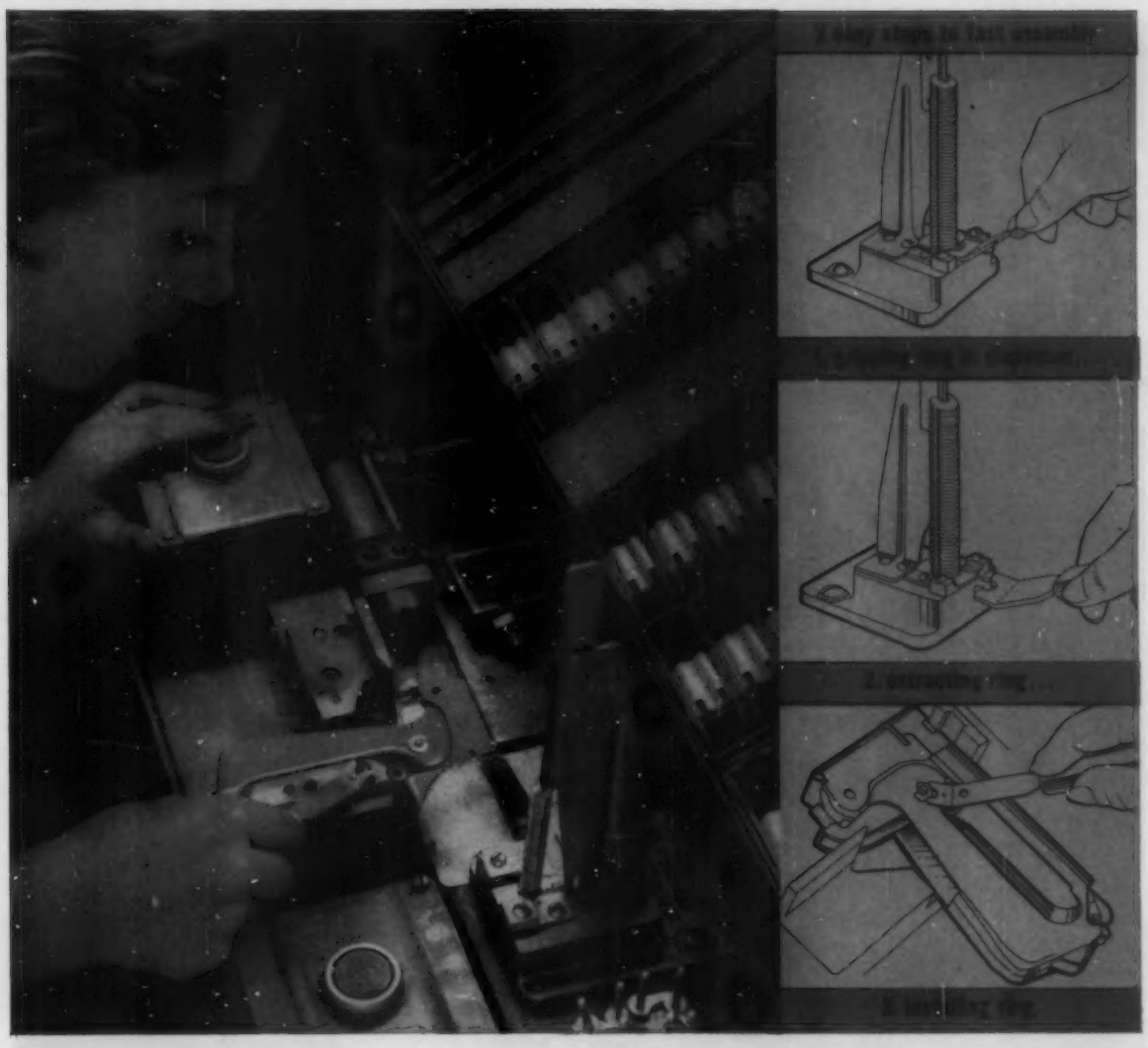


Truarc rings and dispenser speed staple gun assembly 60%

This big production increase was made by Swingline, Inc., Long Island City, N. Y. in assembling the handle lock of their high-compression staple gun.

To speed production, the Truarc Prong-Lock® Series 5139 retaining rings come *pre-stacked* for use on the Truarc *dispenser* (shown in foreground of photo above). Application is simple, fast and requires no skill. The operator, using the Truarc *applicator*, grasps the bottom ring, removes it from the stack, and installs it, quickly and easily, in the staple gun assembly.

The Truarc ring replaced an ordinary flat "C" washer, previously used in this application. *While the unit cost of the washer was lower than that of the Truarc retaining ring, the use of the rings resulted in assembled cost savings of $25.00 per thousand staple guns.* The reasons: a 60% increase in production due to faster, easier assembly with Truarc tools, and the elimination of time-consuming, costly adjustments made possible by Truarc rings. What's more, the bowed Prong-Lock ring improved product design by providing resilient end-play take-up . . . eliminating looseness or binding in the parts.

Truarc retaining rings come in 50 functionally different types . . . as many as 97 different sizes within a type . . . 6 metal specifications and 13 finishes. Truarc assembly tools, pliers, applicators, dispensers and grooving tools are available to speed production of virtually every kind of product. Make sure you have on file the new 16-page Waldes Truarc Assembly Tool Catalog No. AT 10-58. Write for your copy today. And remember Waldes engineers are always ready to help you solve your special application problems. Waldes Kohinoor Inc., 47-16 Austel Place, Long Island City 1, N. Y.

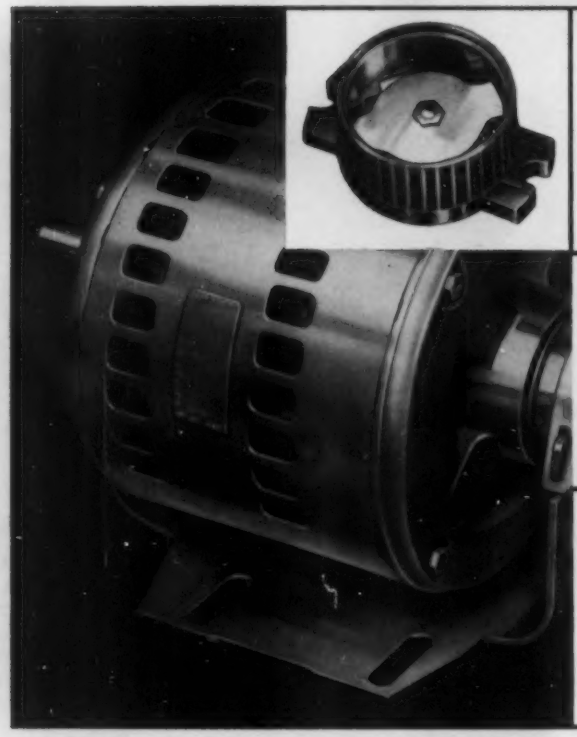
©1959 WALDES KOHINOOR, INC. 9.2

WALDES
TRUARC®
RETAINING RINGS
Waldes Kohinoor Inc., Long Island City 1, N. Y.

TRUARC RETAINING RINGS...THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

Good things begin to happen when you use motors with built-in

KLIXON® TOTAL PROTECTORS



You Eliminate Motor Burnouts

You reduce costly repairs and replacements

You give your product greater reliability

You Safeguard Customer Goodwill

Manufacturers and users of motor-driven equipment can eliminate motor burnouts in their products simply by specifying on their motor purchase order . . . "These motors to have KLIXON Total Protectors."

Built-in as an integral part by the motor manufacturer, KLIXON Protectors permit safe maximum output without failure under abnormal conditions . . . reduce repairs and replacements.

For example, a recent repair shop survey shows that pump motors with built-in KLIXON Protectors reduced motor burnouts by 63.9%.

Protect your motor driven equipment by using motors with built-in KLIXON Protectors. The additional cost is low . . . the savings high. Ask your motor supplier for complete information or write for Bulletin MOPR4.

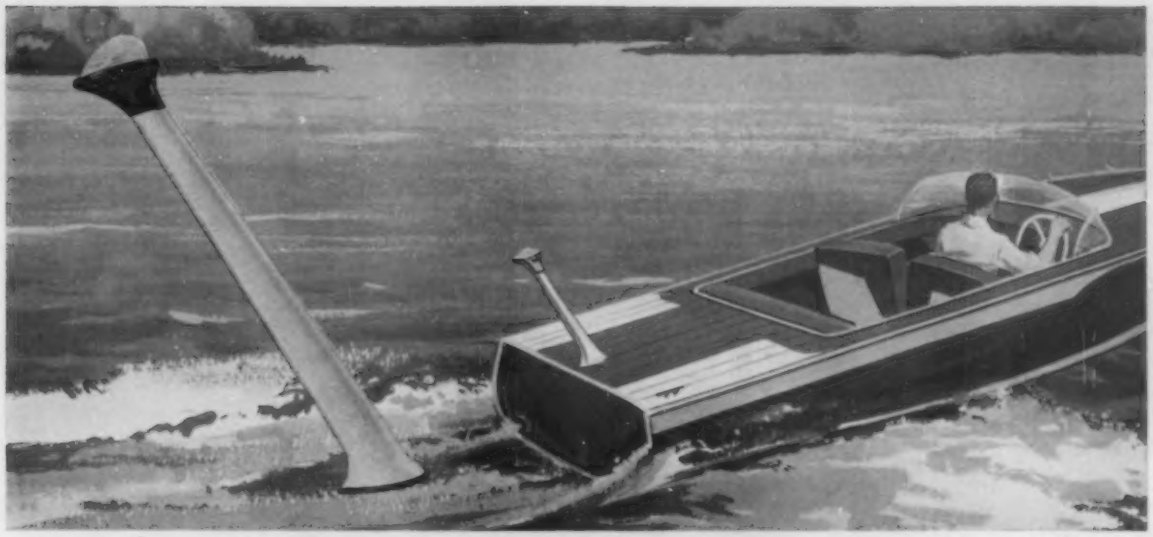
Klixon Total Protectors available to meet your exacting protection requirements against these conditions:

1. Running overload with or without high ambient or ventilation blocked.
2. Locked rotor normal voltage such as caused by mechanical failure of driven load.
3. Locked rotor caused by low voltage where decreased torque is insufficient to start load.
4. Locked rotor with main winding only in circuit resulting from open circuit start switch or open circuit in reversing switch.
5. Locked rotor with start winding only in circuit, such as that resulting from an open main winding circuit or open circuit in reversing switch.
6. Running with both start and main windings in the circuit resulting from start switch failure in closed position or low voltage which prevents reaching switchover speed.

Over 200,000,000 motors are protected against overheating and burning out with KLIXON PROTECTORS

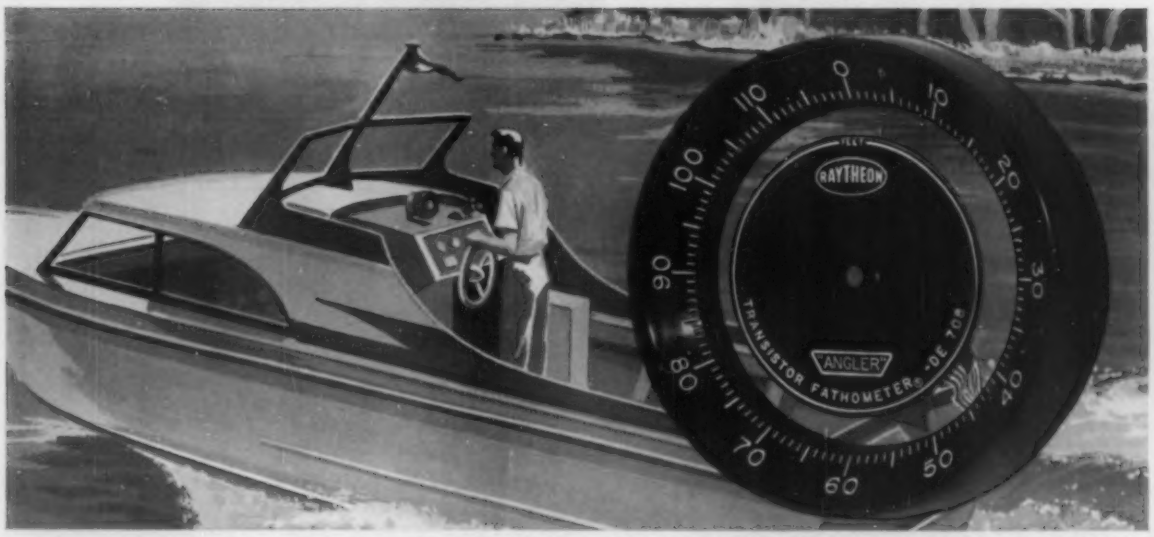
TEXAS INSTRUMENTS
INCORPORATED
METALS & CONTROLS DIVISION
3804 FOREST STREET • ATTLEBORO, MASS.

SPENCER PRODUCTS: Klixon® Inherent Overheat Motor Protectors • Motor Starting Relays • Thermostats • Precision Switches • Circuit Breakers



Handsome and Hardworking

Plexiglas...Implex



Look how PLEXIGLAS® acrylic plastic and IMPLEX®, the high impact acrylic, work together! PLEXIGLAS for the stern light lens shown above and the dial section of the depth finder, below. IMPLEX for the staff of the stern light and the housing of the depth finder.

One or both of these two Rohm & Haas molding materials —strong, handsome PLEXIGLAS and tough, colorful IMPLEX—may be just what you need to give *your* products added usefulness and sales appeal. We will be glad to send you detailed information, and provide design assistance to help you take full advantage of the outstanding properties of PLEXIGLAS and IMPLEX.

Chemicals for Industry

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

In Canada: *Rohm & Haas Company of Canada, Ltd., West Hill, Ontario*

Alcoa puts the metal where you want it

How BIG an impact have you seen lately? Alcoa can now make them up to 12 in. in diameter and 60 in. long.

When Alcoa's new 2,500-ton press hits an aluminum alloy slug, a giant impact is formed with the combined strength of an extrusion and forging.

Like their small brothers, these big new impacts can save you money. They are produced in one fast operation. There's no parting line to be ground. No scale to be removed. No draft to be cut off. Impacts have forged bases and extruded sections. Multiple parts can often be combined into one integral impact eliminating welded or mechanical joints. Machining is reduced, and excessive material waste is eliminated.

You can get these big new Alcoa® Impacts in many alloys with tensile strengths up to 75,000 psi. Also made from aluminum powder metallurgy alloys which provide excellent properties at elevated temperatures.

Alcoa Impacts are unfailingly sound. They have smooth, corrosion-resistant surfaces. You can have them in plain or complex shapes with design features combining those of forgings and extrusions—flanges, steps, multiple walls, bosses, ribs.

In impacts, as well as forgings, castings, extrusions and screw machine parts . . . Alcoa puts the metal where you want it. A call to Alcoa can mean ingenious design solutions. Start now; write for *Metal in Motion*, Alcoa's new 34-page brochure on impacts. Aluminum Company of America, 908-D Alcoa Building, Pittsburgh 19, Pa.

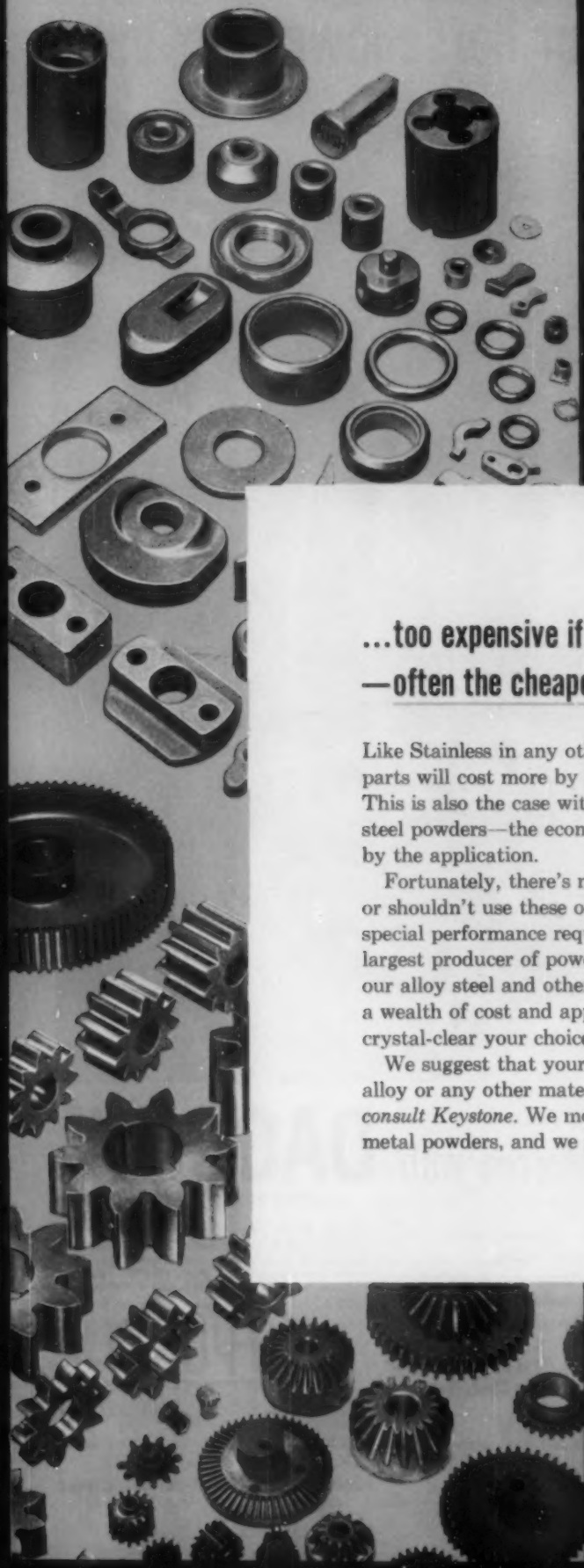
ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

Alcoa puts the metal where you want it . . . in impacts, castings, forgings, extrusions and screw machine parts.

CIRCLE 47 ON READER SERVICE CARD→

FACTS ON **KEYSTONE** POWDER METALLURGY



Powder Metal Parts of STAINLESS and ALLOY STEELS

...too expensive if you don't need 'em —often the cheapest, if you do!

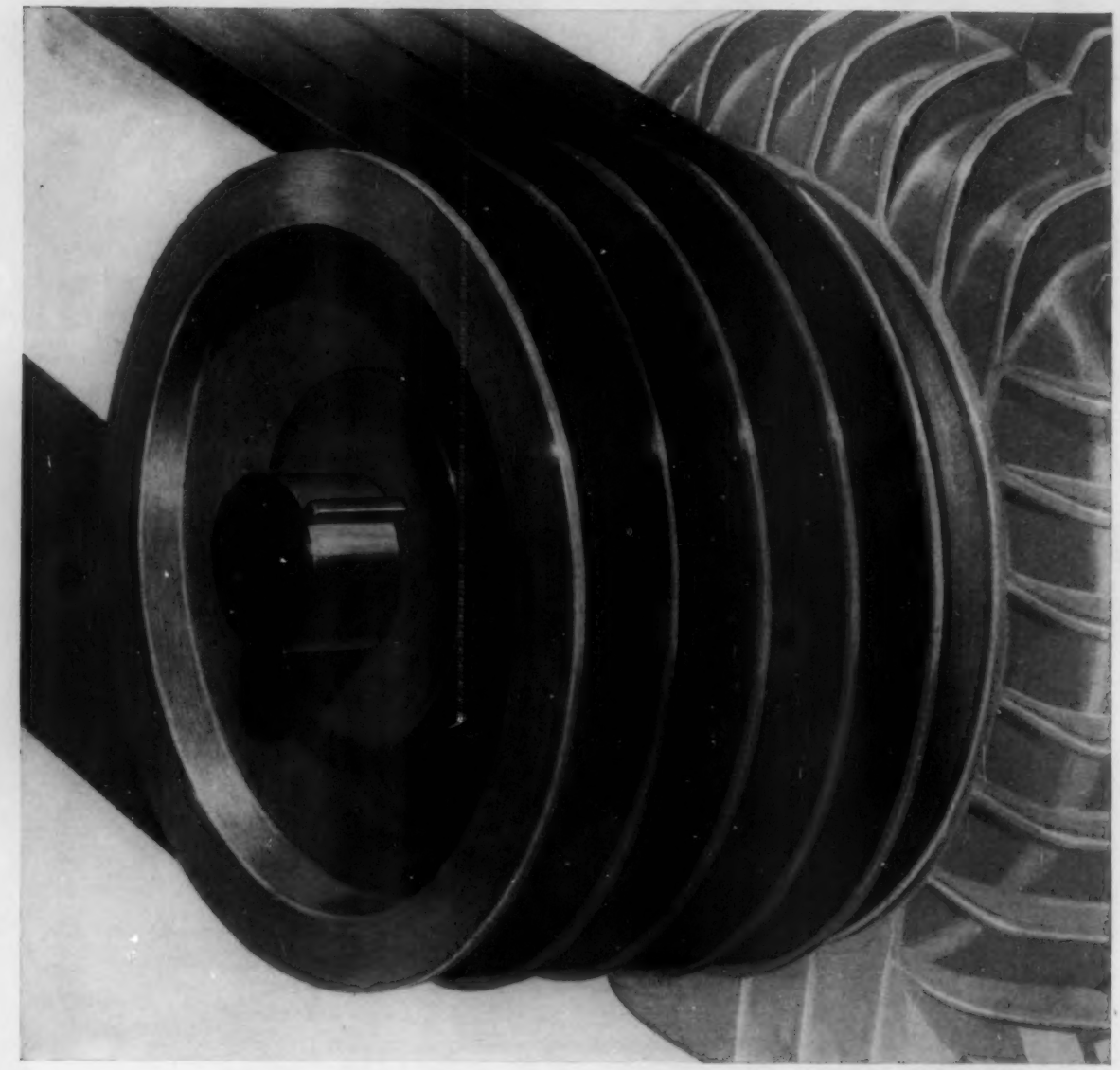
Like Stainless in any other form, your powdered stainless parts will cost more by the pound and do more by the piece. This is also the case with parts of high-strength alloy steel powders—the economies are properly determined solely by the application.

Fortunately, there's no mystery about whether you should or shouldn't use these outstanding materials for your special performance requirements. Our experience as the largest producer of powdered stainless parts is as intensive as our alloy steel and other metals background is broad. We have a wealth of cost and application data that will make crystal-clear your choice and the alternatives to consider.

We suggest that your first step in deciding on stainless, alloy or any other material for your projected part is to *consult Keystone*. We mold and sinter all the commercial metal powders, and we play no favorites!

Keystone
CARBON COMPANY
St. Marys, Pa.
POWDERED METAL PARTS DIVISION

Get up to 300% greater horsepower per belt!



Specify super-rated V-belts reinforced with DACRON®

POLYESTER FIBER

You'll get up to three times the horsepower of ordinary belts when you specify super-rated V-belts reinforced with Du Pont "Dacron"* polyester fiber. Super-rated belts reinforced with "Dacron" give you greater horsepower without an increase in drive size. Or they give you more compact drives without a sacrifice in power . . . plus amazing resistance to shock loads and flexing.

For the next drive you install, be sure you specify super-rated V-belts reinforced with tough, long-wearing Du Pont "Dacron". Du Pont makes the "Dacron" fiber used by belt manufacturers in producing their finest-quality V-belts.

FREE BOOKLET: "Du Pont 'Dacron' Sets New Standards for V-Belt Performance". Write: E. I. du Pont de Nemours & Co. (Inc.), 31E Centre Road Bldg., Textile Fibers Department, Wilmington 98, Delaware.

*"Dacron" is Du Pont's registered trademark for its polyester fiber.

DU PONT

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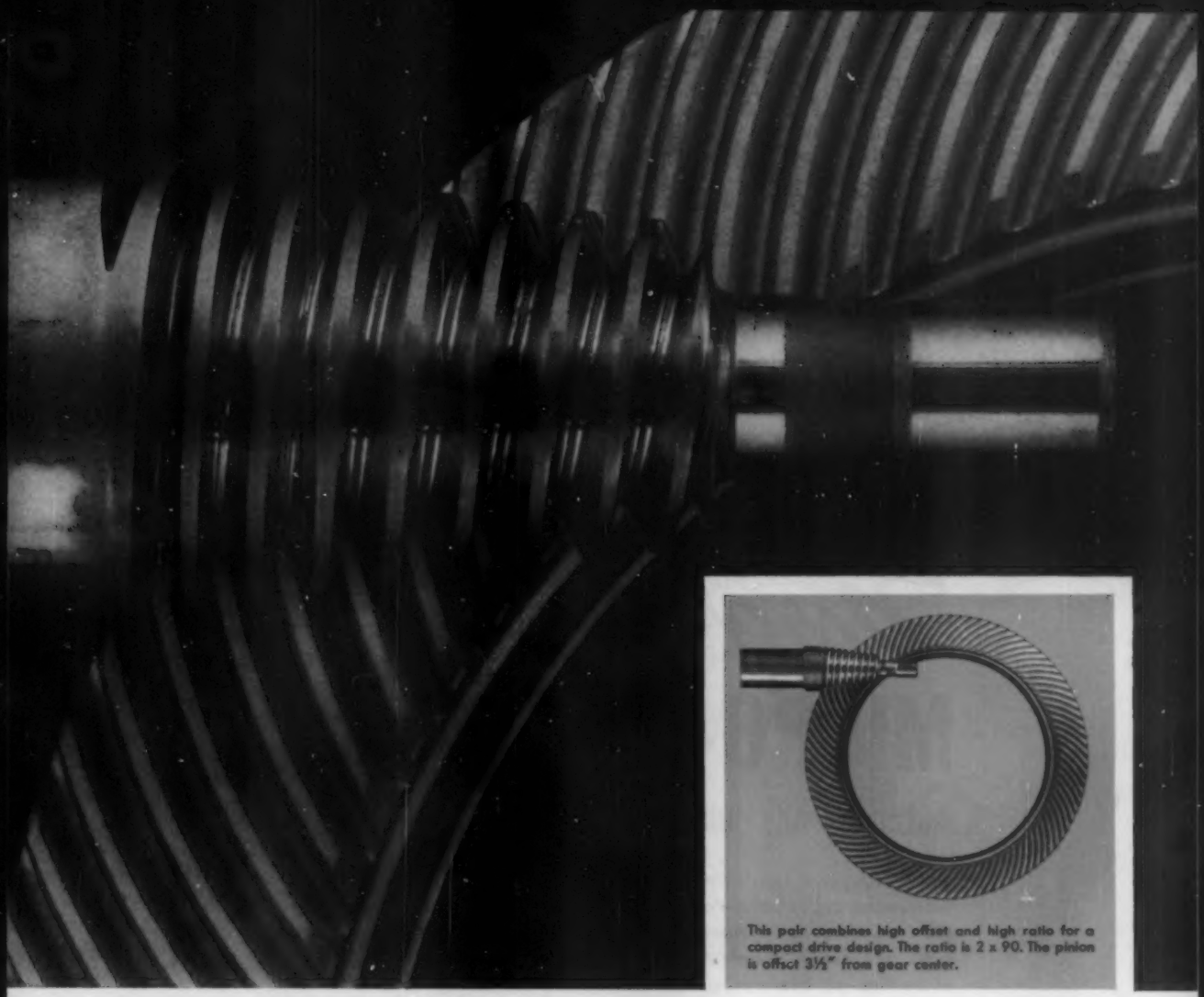
Better Things for Better Living . . . through Chemistry

Enjoy "The Du Pont Show With June Allyson"—Monday Nights—CBS-TV



This pair combines high offset and high ratio for a compact drive design. The ratio is 2 x 90. The pinion is offset 3½" from gear center.

See how the teeth "wrap around" this high-reduction pinion

This is a high-ratio hypoid gear. In principle, it is not different from more conventional hypoids produced by the Gleason Works. *But . . .*

If you look closely at the pinion, you'll notice that the teeth tend to "wrap around" it. This design is extremely well suited for high reduction, strength and compact design.

The result is a conical (or sometimes cylindrical) pinion which permits *continuous tooth action—even with just one or two teeth!* Compared to corresponding bevel pinions, its diameter is greater for higher strength. An extended shank on cylindrical pinions makes *very rigid* straddle mountings practical.

You can design a *compact* unit, because high offset is possible! For high-offset *or* high-ratio pairs, the "wrap around" tooth design provides an extra measure of the smooth, quiet tooth action of hypoid gears.

High-ratio hypoids can be cut on the same Gleason equipment that is used on more familiar spiral bevel gears and hypoids. You can also use the same testers, quenching presses and other auxiliary Gleason equipment you're using now. Grinders are available for applications requiring precision finish.

High-ratio hypoids can be produced by the Gleason Works for ratios of 1:10 or 1:40 or even higher. They are finding a growing number of applications in such diverse fields as farm machinery, instrumentation and office equipment.

You can get more information about Gleason high-ratio hypoid gears by writing for free literature. Submit your prints for recommendations.

GLEASON WORKS

1000 UNIVERSITY AVE., ROCHESTER 3, N.Y.

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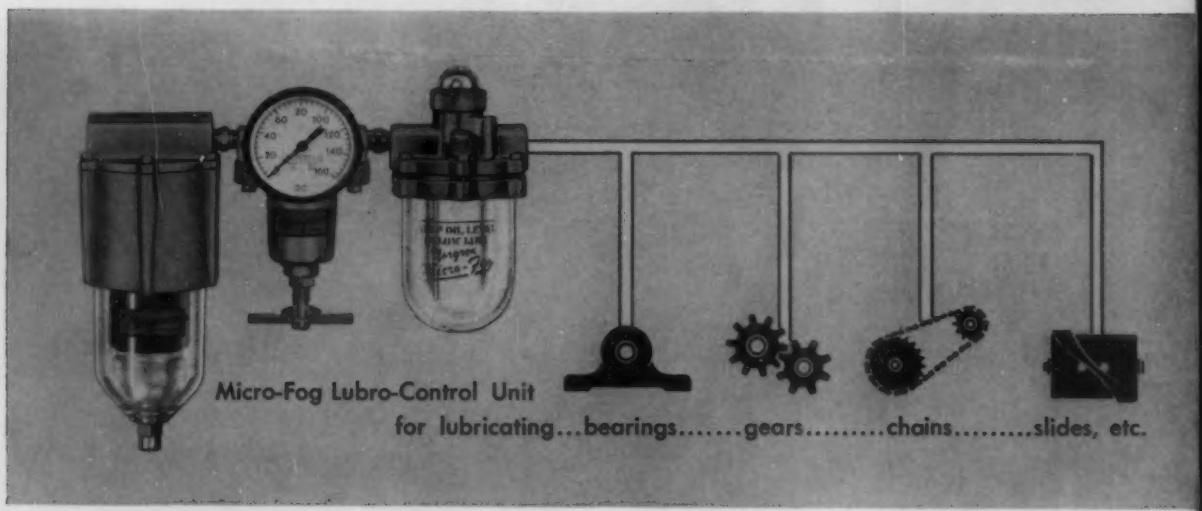


Norgren MICRO-FOG LUBRICATION

Automatically lubricates every bearing surface on a machine

About 10 years ago, a new type of oil fog lubrication, called Micro-Fog was marketed by the C. A. Norgren Co. More and more machine tools are being completely lubricated with Micro-Fog—all bearings, gears, chains, slides, ways.

With any method of lubrication, the only oil that actually lubricates is the thin film that separates the bearing surfaces. Any additional lubricant is a waste and may even be harmful, causing overheating through fluid friction.

An air-borne fog of extremely small oil particles is created by a Norgren Micro-Fog Unit. This Norgren Micro-Fog can be conveyed long distances through low pressure pipelines directly to the bearing surfaces.

Micro-Fog provides thorough lubrication

At the bearing surfaces a nozzle-like fitting, called a reclassifier, causes the small dry oil particles to combine into larger wet particles. These impinge upon the bearing surfaces and cover them thoroughly and continuously with a protective film of oil.

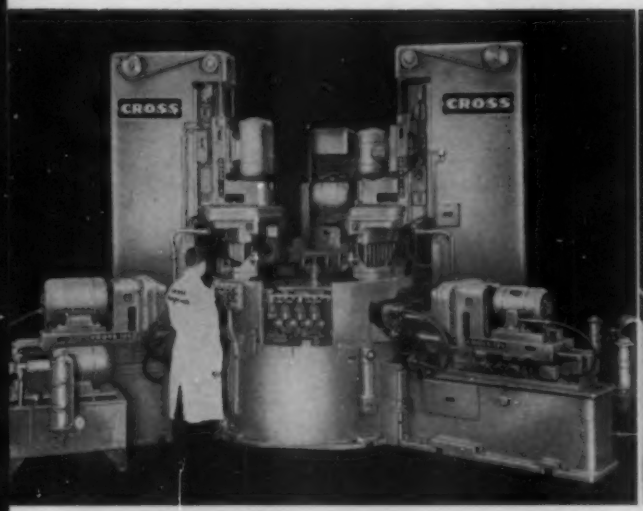
A Norgren Micro-Fog Lubro-Control Unit is a combination of three Norgren Units—an air line filter to remove the compressed air contaminants, a pressure regulator to accurately control pressure and a Micro-Fog Lubricator.

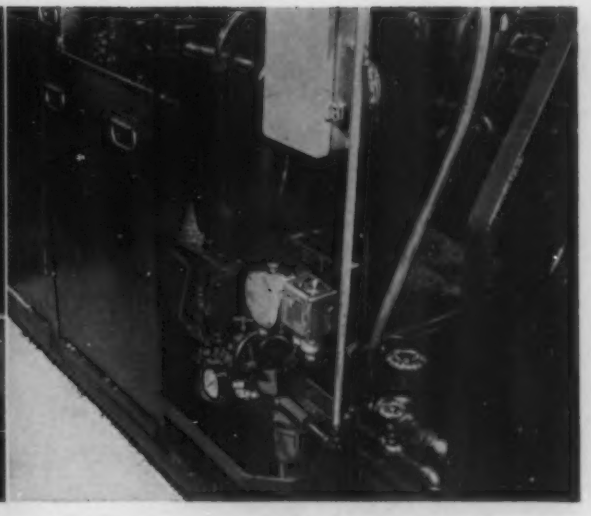
Norgren Lubro-Control Units are adjustable to deliver automatically just the right amount of Micro-Fog to provide continuous lubrication.

A few of the benefits provided by Micro-Fog:

Longer bearing life. Reduced downtime, maintenance and bearing replacement costs. Lower bearing temperatures. Less lubricant used—lower lubricant costs. Centralized lubrication, eliminating time-consuming hit and miss methods. No excess of lubricant—minimum product contamination and easier housekeeping.

Today, Micro-Fog Lubro-Control Units are operating successfully on practically all types of equipment. These applications range from high-speed precision grinders, running at 450,000 rpm, to huge rolling mill bearings on shafts as large as 34″ in diameter and turning at relatively slow speeds.



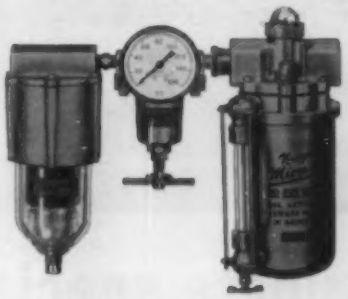


The 150 ball bearings and 70 spur gears on this machine are lubricated by a single Norgren Micro-Fog Lubro-Control Unit. Results: 1. Bearing and gear box seals eliminated. 2. Oil leakage of lubrication system eliminated and safer floor conditions around machine. 3. Oil usage greatly reduced.

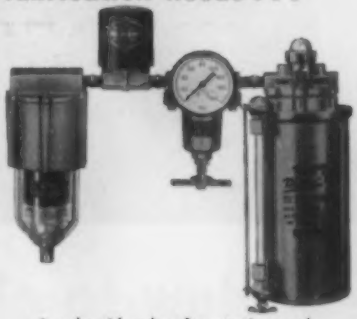
With Norgren Micro-Fog, ½ pint of oil per day does a better job of lubrication than the 15 gallons of oil used per day with the previous circulating system. On this automatic screw machine, the Norgren Micro-Fog Unit lubricates sleeve bearings, anti-friction bearings, slide blocks, guides, chucking mechanism and gears.

Wide selection of Norgren Units meets most machine lubrication needs . . .

Small, compact units for use where space is tight.



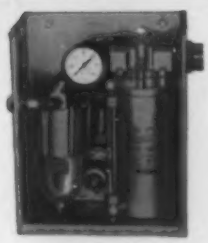
A Norgren Lubro-Control Unit can be made up of any combination of Norgren filter, regulator, lubricator.



A solenoid valve for starting and stopping lubrication as machine is turned on and off can be incorporated as part of a Lubro-Control Unit.

This Lubro-Control Unit is small, compact and complete with filter, regulator and lubricator. It measures only 6 1/32" x 6 1/32" x 5 5/16".

Compact and complete, this Norgren Unit includes automatic alarm controls that safeguard the machine against lubrication failure.



This cabinet unit can be entirely enclosed and locked. It is compact and complete and is equipped with automatic alarm controls.

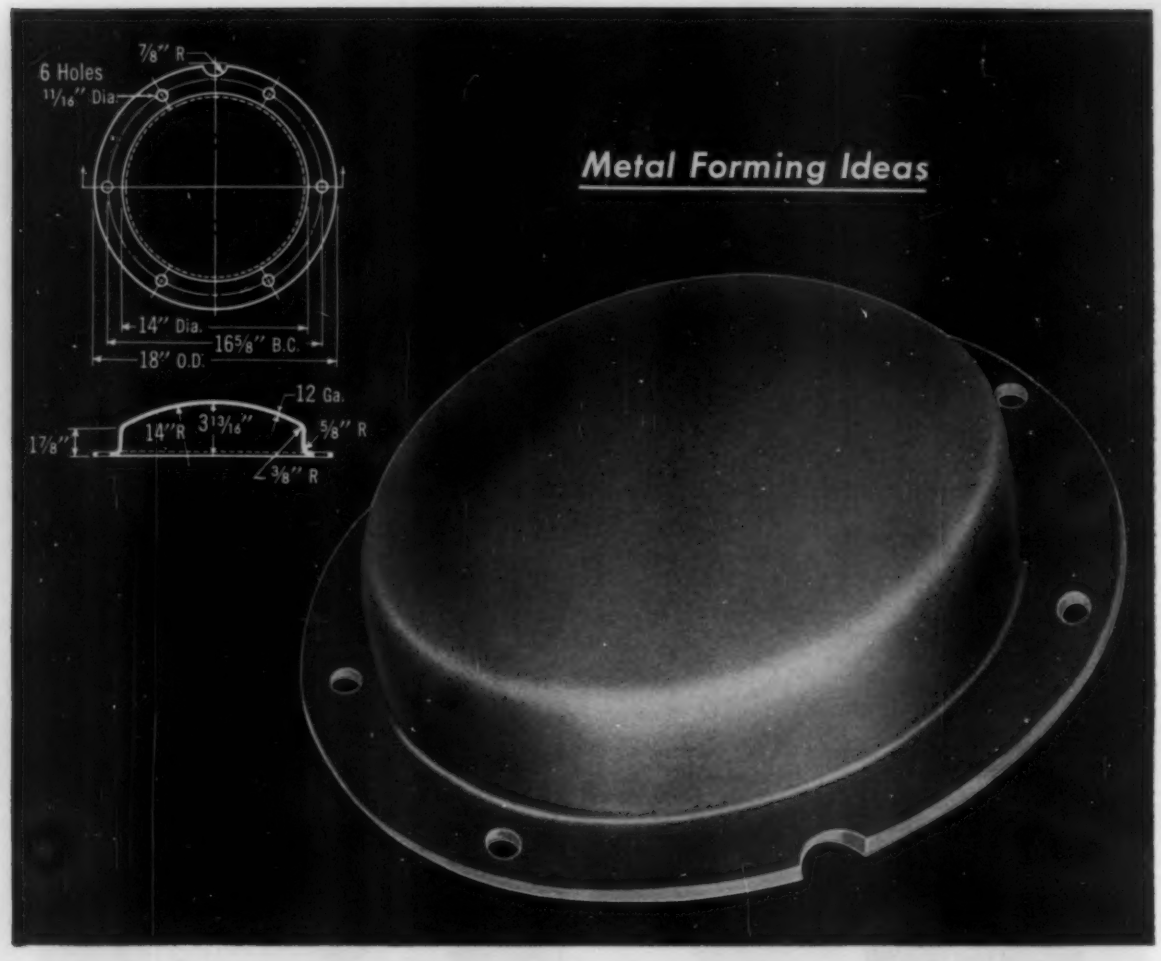
The above is only a partial listing of the complete Norgren line. For complete information on the large selection of Norgren Micro-Fog Lubro-Control Units available, ***WRITE FOR DESCRIPTIVE LITERATURE***

FOUNDED 1926

C. A. NORGREN CO.

3428 SO. ELATI STREET ENGLEWOOD, COLORADO

1602



How to eliminate special tooling in the design of custom-formed parts

Custom stampings, formerly prohibitive cost-wise, can now be inexpensively formed through the use of existing dies from COMMERCIAL'S "Die Bank" of almost 50,000 different forming die components.

A case in point: Wheel covers for American Coleman's aircraft towing tractor. They're important for the protection of the power transfer yokes in the tractor's four-wheel drive.

Stamping was first considered as the best method for forming them. The original low quantity involved and the amortization of $2,300 for special forming die costs, however, made the stamping unit costs impractical.

The covers were therefore first produced as machined, malleable iron castings at a cost of $8.49 per unit. A switch to hand spinning later reduced this cost to a still high $3.50 per cover.

American Coleman then discovered and investigated COMMERCIAL'S "Die Bank". From 24 basic shapes ranging 4" to 72" in diameter and involving metal thickness from 20 gauge to ¾" —all available through the use of existing dies adapted to presses up to 2000 ton capacity—emerged an entirely practical and economical solution to the unit cost problem.

The design: A standard, dished, offset shape with vertical and horizontal flanges and dish radius equal to its dished diameter. The wheel cover of 12 gauge, stamped steel now provides complete protection, necessary yoke clearance and a pleasing appearance.

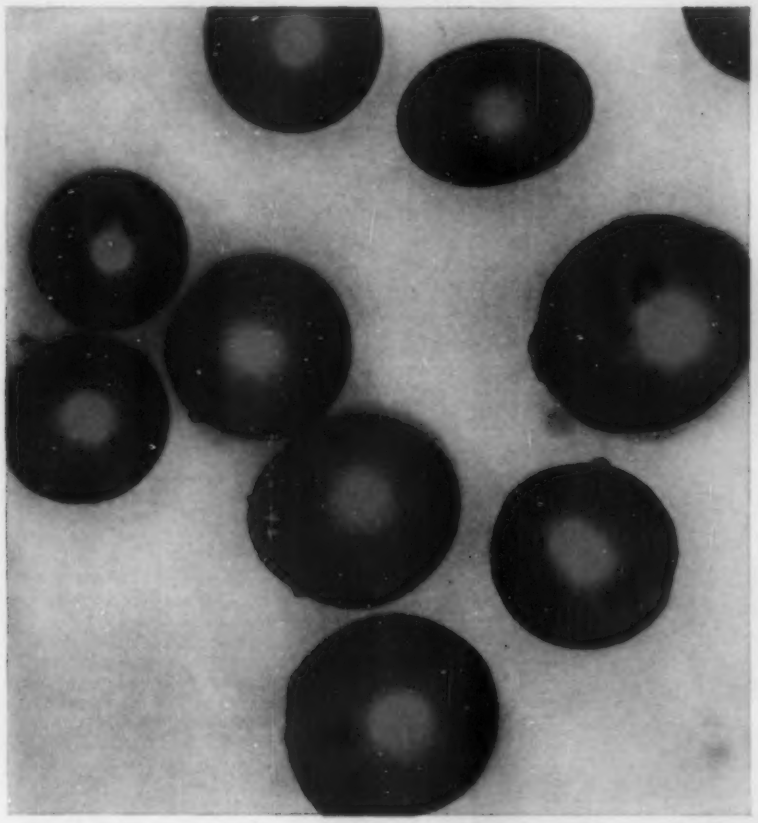
Best of all, by using an existing forming die from COMMERCIAL'S "Die Bank", the actual tooling charge was only $80 for a simple modification of a single die component. And the unit cost was slashed to a practical $2.59.

The final result: A strong, lightweight wheel cover with a smooth surface for finishing which now completely and economically meets all requirements.

If your component requirement involves a custom-formed or unusual shape, and if the high cost of tooling prohibits its economical forming, the "Die Bank" service at COMMERCIAL may be just what you've been looking for. There's a quick way to find out. Just send along a blueprint, sketch or prototype of your part to Commercial Shearing & Stamping Company., Dept. G-17, Youngstown 1, Ohio.

COMMERCIAL
shearing & stamping

30 MILLION OF THESE JET-FORMED SPHERES IN EVERY INCH OF BEARING SURFACE!



JET PROCESS BLASTS MOLTEN ALLOY INTO UNIFORM PARTICLES . . . so small that thirty million will form a thin layer only one inch square! This sintered layer is the bearing surface of Federal-Mogul sleeve bearings.

Molten copper-lead, alloyed to exact specifications, is poured into a special inert-atmosphere reaction crucible. Here it's blasted by a high-speed fluid jet to form the dense powder shown at left.

Because of the uniform particle size of this powder, the bearing surface of each F-M copper-lead sleeve bearing has precisely the same alloy composition and high adhesion to the steel backing as every other F-M bearing of the same alloy type!

YOU CAN SEE THE CONSISTENT SIZE in the photomicrograph. What you *can't* see is the consistent alloy composition which produces uniform bearing properties and performance in any alloy type.

Federal-Mogul makes engine bearings for every condition of speed and load. You can select from among five different sintered copper-lead alloys, all permanently bonded to precision-formed steel backing. Our Engineering Department is available to you for consultation or recommendations on bearing design and application. For more information, write Federal-Mogul Division, 11043 Shoemaker, Detroit 13, Michigan.

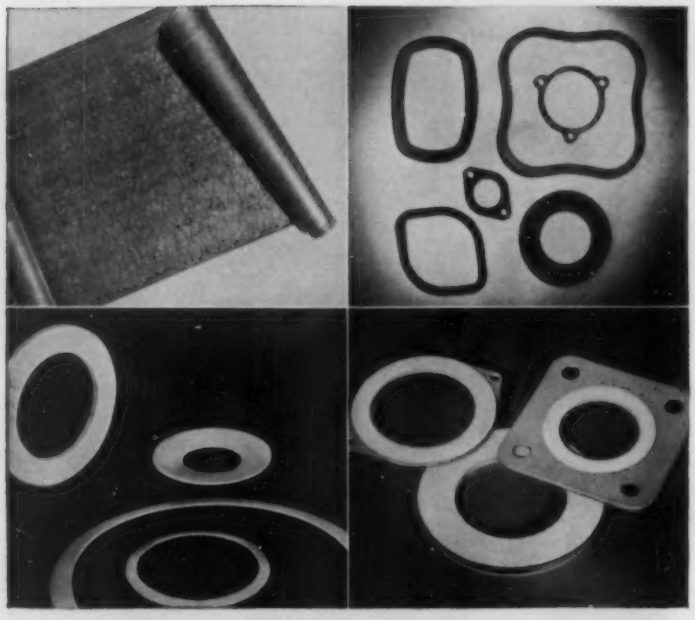
A COMPLETE LINE! Steel backed bearings with a selection of many different alloys for virtually any bearing application—Plain and bimetal bushings in bronze, steel or aluminum. Precision thrust washers in solid bronze, or sintered alloys on steel (one or both faces). Rolled split spacer tubes in steel, aluminum or stainless.

FEDERAL-MOGUL

sleeve bearings · bushings · spacers · thrust washers

DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC.

GASKETS
in Design
Engineering



High temperature gaskets come in sheet form (upper left) or cut (upper right); Teflon gaskets are available solid (lower left) or jacketed (lower right).

CHOOSE THE GASKET FOR THE JOB

Garlock can furnish an extensive line of gasketing materials to meet a wide range of service conditions. Specify your sheet or cut gaskets from the following: GARLOCK 7021 synthetic rubber and long fibre asbestos, superior for hot oil service at 700° F; GARLOCK 7228 high quality neoprene and long fibre asbestos, for gasoline, naphtha, benzine and other hazardous liquids and solvents, temperature to 300° F; GARLOCK 8748 Buna-N binder and long fibre asbestos, an outstanding gasketing material for carburetor service, temperatures to 500° F; GARLOCK 7705 synthetic rubber with blue African asbestos fibre, excellent against hot and cold mineral acid; GARLOCK 900 long fibre asbestos with synthetic binder, for service against steam, gas, air, temperatures to 700° F; GARLOCK 7772, long fibre asbestos with synthetic binder, white in color, for service in chemical and petrochemical process equipment where leeching is a problem, temperatures to 700° F. Other gasketing materials available to meet your specific requirements.

For corrosives at extreme temperatures, Garlock offers Teflon* gaskets in a variety of styles. SOLID TEFLON GASKETS for use on A.S.A. metal-to-metal flanges are chemically inert, tough, non-adhesive at temperatures from −110° F to +500° F. Furnished in ring or full face sizes for all standard pipe sizes from 1″ to 12″. Will withstand pressures up to 300 psi. TEFLON-JACKETED GASKETS offer the advantage of using Teflon without sacrificing resiliency and deformability. Applied widely to glass-lined process equipment, light metal flanges, glass pipe flanges and fittings. Fillers are available in all types of gasketing materials. SPECIAL TEFLON GASKETS of all shapes can be furnished to your drawing or template. Catalog AD-154.

GARLOCK

Discuss gasketing with your local Garlock representative. You'll find him at the nearest of Garlock's 26 sales offices and warehouses throughout the United States and Canada. Or, write The Garlock Packing Company, Palmyra, N. Y.

Canadian Div.: The Garlock Packing Company of Canada, Ltd.

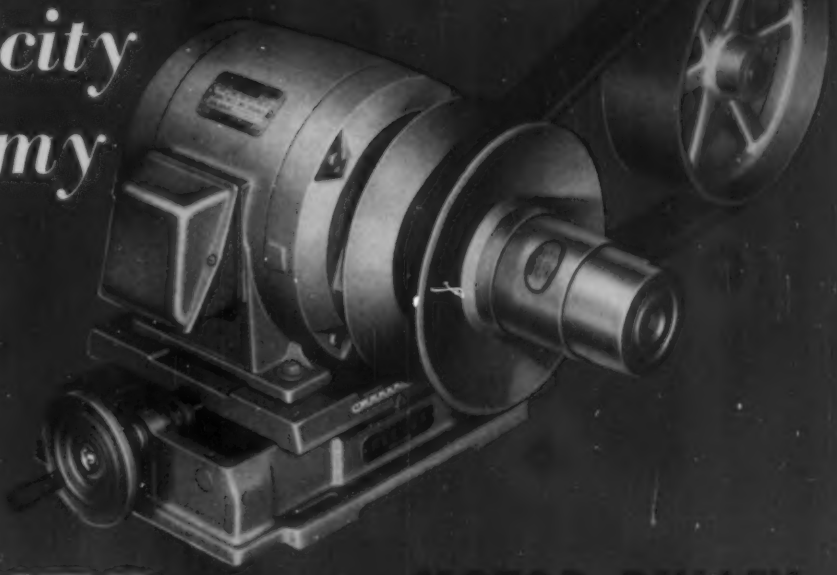
Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

*DuPont Trademark for TFE Fluorocarbon Resin

54 CIRCLE 54 ON READER SERVICE CARD

Variable Speed Simplicity Economy



REEVES vari-speed MOTOR PULLEY

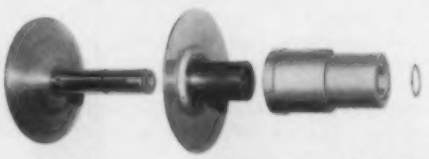
The obvious advantages you gain from this Reeves Motor Pulley design are accurate variable speed control, low cost operation, no problems.

It's as simple as this: There are two smooth-faced cone-shaped discs, one mounted in fixed position on the motor shaft, the other designed to slide laterally on the hub of the fixed disc. Belt tension spring automatically maintains pressure on the sliding disc for correct belt tension at all output speeds, while smooth, stepless speed changes are accomplished by adjusting the sliding motor base.

Disc Assemblies are available in nine sizes, ⅓ hp. through 15 hp. to fit either old or new NEMA motors. Speed ranges up to 4:1. Separately mounted countershaft assemblies are available to match any of your machine speed requirements. Your Reliance Sales Engineer has all the facts. Call him . . . or if you prefer, write for Bulletin No. GV-582-1.

G-1650

ONLY 3 MAIN PARTS!



Fixed Disc Sliding Disc Belt Tension Spring

ONE LUBRICATION POINT!

Reeves exclusive "Close Grooving" maintains a film of lubricant between hub length of fixed disc and bore of sliding disc . . . prevents sticking.

Product of the combined resources of Reliance Electric and Engineering Company and its Reeves and Master Divisions

RELIANCE ELECTRIC AND ENGINEERING CO.

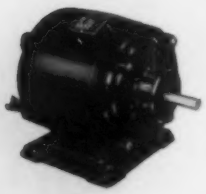
DEPT. 304A, CLEVELAND 17, OHIO
Canadian Division: Toronto, Ontario
Sales Offices and Distributors in Principal Cities

Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.

The POWER behind the leading products

3500 STANDARD
built-to-order Bodine Motors!
300 STOCK Bodine Motors!

FOR office machines, instruments, timing devices, pumps, coin-handling equipment, communication equipment, therapeutic devices, sound-recording and reproducing equipment, machine tools, plus many other applications.



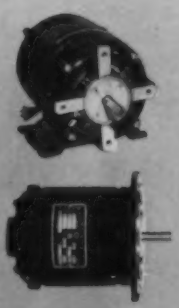
TYPE N MOTORS:
Bodine Type N Motors are manufactured in three basic sizes, with each size available in several different lengths. The smallest is only 3⅜" in diameter...the largest just over 5½" in diameter. Standard ratings range from 1/150 to 1/6 horsepower at 1725 rpm...however, Type N Motors can be furnished in other ratings and speeds. Windings available: split-phase, capacitor, synchronous, shunt, compound, universal (series wound, including governor controlled).

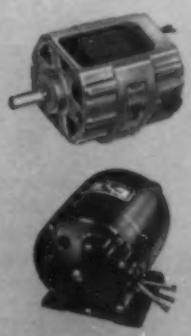
TYPE K-2 MOTORS:
The K-2, which is one of the smallest distributed wound motors manufactured today, is only 2⅜" high. Normal 60 cycle output ranges from 1/2000 to 1/500 horsepower on continuous duty. Power is substantially greater than motors of clock type construction. These motors are well suited for applications, such as timing devices, instruments, and related equipment which calls for relatively low output, and continuous trouble-free service.

TYPE V-10 MOTORS:
Supplied with a series winding, the V-10 has variable speed characteristics, and a full load speed of 5000 rpm. It has a high starting torque and rapid acceleration, and can be operated on either DC or AC. This is a compact motor and offers generous power with light weight and small enclosure. Three tapped holes in the end shield allow end mounting. Optional horizontal base mounting requires a motor frame strap.

300 Different Stock Type of Motors Available Immediately from Distributors Located in Major Manufacturing Areas

AND a wide range of special purpose motors and modifications





Small Speed Reducer Motors in over 1600 standard specifications!

Motors with built-in speed reducers are used extensively by manufacturers of motor-driven machines, who desire a compact, low-speed motor. By combining the motor and speed reducer in one unit, all cumbersome and complicated speed reducer transmissions, such as belts, gears, and chains are eliminated. Design and installation time are saved. The unit is compact, quiet, and attractive in appearance. Trouble-free performance is assured.

TORQUES
1.3 in. oz. to 350 in. lb.

SPEEDS
0.6 to 300 rpm.

RATIOS
6:1 to 2880:1

Group 1...Speed reducer motors designed for transmitting low torques over a wide range of speeds. Motor diameter about 2⅞" to 3⅝". Worm of hardened, long-wearing, nitralloy steel cut on motor shaft (except for the low powered V-10R and NSP-11R). Laminated bakelite primary gear. Secondary gear, bronze on ratios 180:1 or more; laminated bakelite on lower ratios. Ratios—Single Reduction Ratios—6:1 to 30:1 Double Reduction Ratios—36:1 to 1120:1.

Group 2...A double worm-gear speed reducer designed to deliver moderate (up to 52 in. lbs.) torques at low speeds. Diameter of motor approximately 3⅝". Both primary and secondary worms are of hardened nitralloy steel. Laminated bakelite primary gear. Hard bronze secondary gear. Motor shaft has prelubricated ball bearings. Secondary and driveshafts have bronze sleeve bearings, grease lubricated. Reduction ratios—60:1 to 1350:1.

Group 3...A single reduction right-angle worm-gear reducer, designed for transmitting moderate (up to 21 in. lbs.) torques. Diameter of motor approximately 3⅝" to 4⅜". Separable hardened and ground steel worm. Laminated bakelite gear on steel hub. Motor shaft has ball bearings with built-in grease seals. Ratios —10:1 to 60:1. Motor Mounting—Any position except with gear housing above motor.

Group 4...A double worm-gear reducer for transmitting high (up to 219 in. lbs.) torques at low speeds. Motor diameter approximately 4⅜". Worms are accurately ground from hardened steel. The bakelite primary gear assures quietness; the hard bronze secondary gear provides long life. Ball bearings used throughout. Reduction ratios range from 72:1 to 2880:1. Any specified mounting position may be obtained except gear head over motor.

Group 5...A single reduction, right-angle worm-gear reducer, capable of transmitting substantial (up to 73 in. lbs.) torques. Motor diameter 4¾" to 5¾". Separable hardened and ground steel worm. Gears of laminated bakelite or hard gear bronze, depending on torques delivered. Motor shaft has ball bearings, grease-lubricated with self-seals. Ratios—10:1 to 60:1.

Group 7...Extra rugged reducer for driving heavy (up to 198 in. lbs.) **loads continuously** with ample reserve for overloads. Loads are carried on ball bearings. All forces directly transmitted to the motor feet. Separable steel worms are hardened and ground. Gear is of bronze. Ratios—8:1 to 48:1. Motor may be assembled to mount in any position except gear head over motor.

BODINE
fractional / horsepower
MOTORS

BODINE ELECTRIC COMPANY
2510 West Bradley Place Chicago 18, Illinois

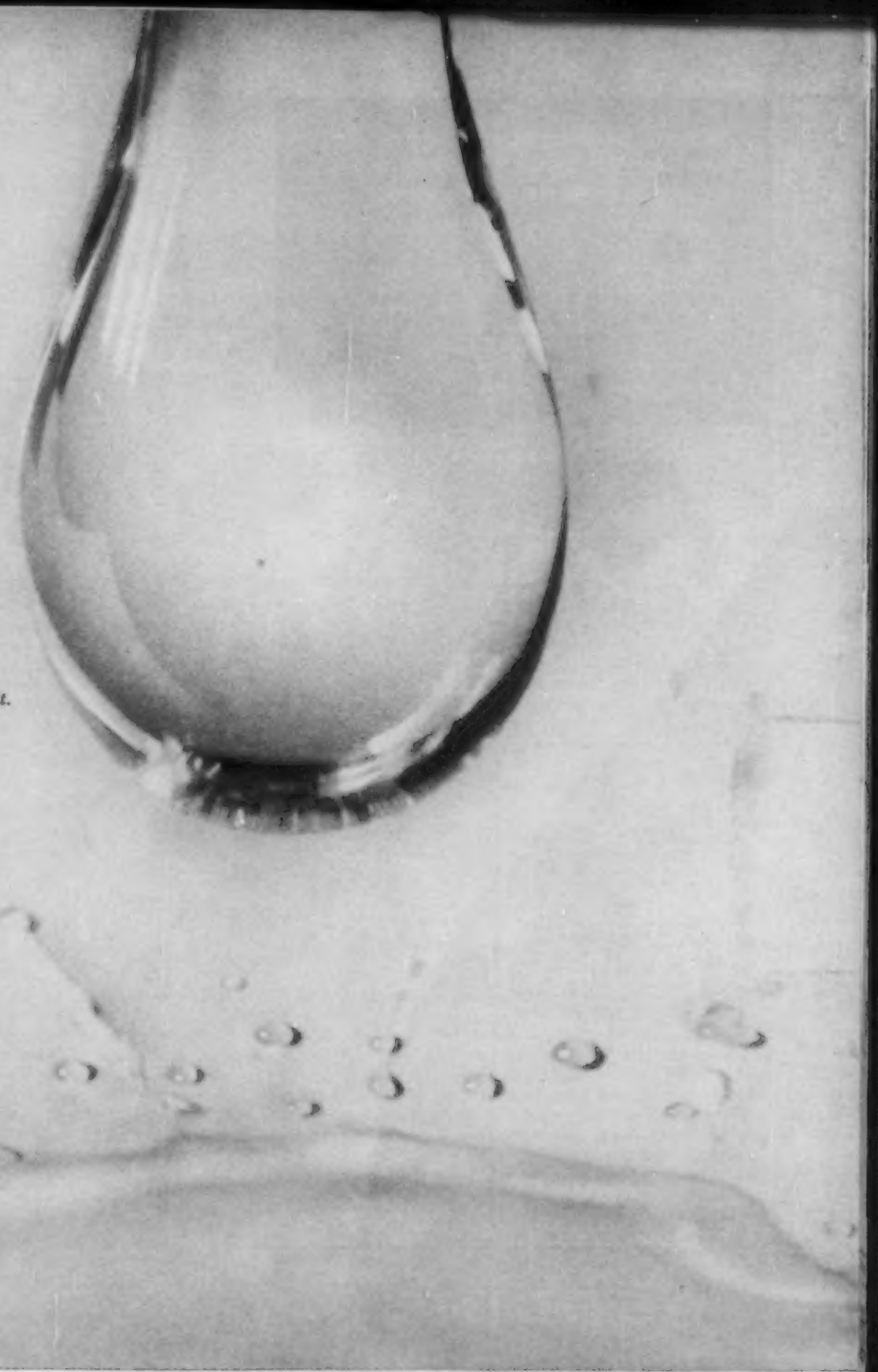
FREE
12-page technical bulletin

Additional detailed information on the more widely used Bodine Motors is contained in newly revised bulletin S-2. Copies available on request.

K-2 Speed reducer motor designed for continuous duty applications requiring sturdy construction and exceptional reliability. Small, rugged. Available with built-in spur or helical gearing. Synchronous or nonsynchronous. Distributed windings are used for highest efficiency. Speeds 300 rpm. to 0.7 rpm. Torque 1.3 to 120 inch ounces. Frame-die cast zinc except for the steel laminations. Ball bearings are standard. Ratios—6:1 to 1800:1. Capacitor is included with each motor.

CIRCLE 58 ON READER SERVICE CARD→

water



comes in oceans, rivers, lakes, wells,
drops, buckets, pitchers and glasses.
it quenches thirsts, cooks food, puts
out fires, makes coffee and
brushes teeth. it spins mills,
runs electro-plants, cools motors
and power factories.
it spawns fish, sprinkles lawns,
floats boats, washes children
and grows flowers.

it sustains and nurtures.
it bends if you give it purpose.
it reshapes itself if you give it reason.
it is needed, wanted, feared,
praised and prayed for.

it is at the heart of all life.
it is in the arteries of all industry.
it is as close to us as skin
but as taken for granted as sky.

the end of water seems unbelievable.
if it is not on the horizon, it is just over it.
if it is not within sight,
it is just 'round the bend.
if it is not in the glass,
it is just in the spigot.

. . . this is the grand mirage . . .
the self-delusion that prevails
though the wells run low
and the streams go dry
and the water slips away.

we know water.
we know its ways.
we've learned its habits.
we've pulled it out of swamplands,
pushed it over mountains,
pumped it into deserts,
tunneled it through granite,
and rescued it from pollution.

above all else,
we know the need for it.
that is why,
for 130 years,
we've developed new uses for,
powered new factories with,
diverted the courses of
and jealously stood guard over
water.

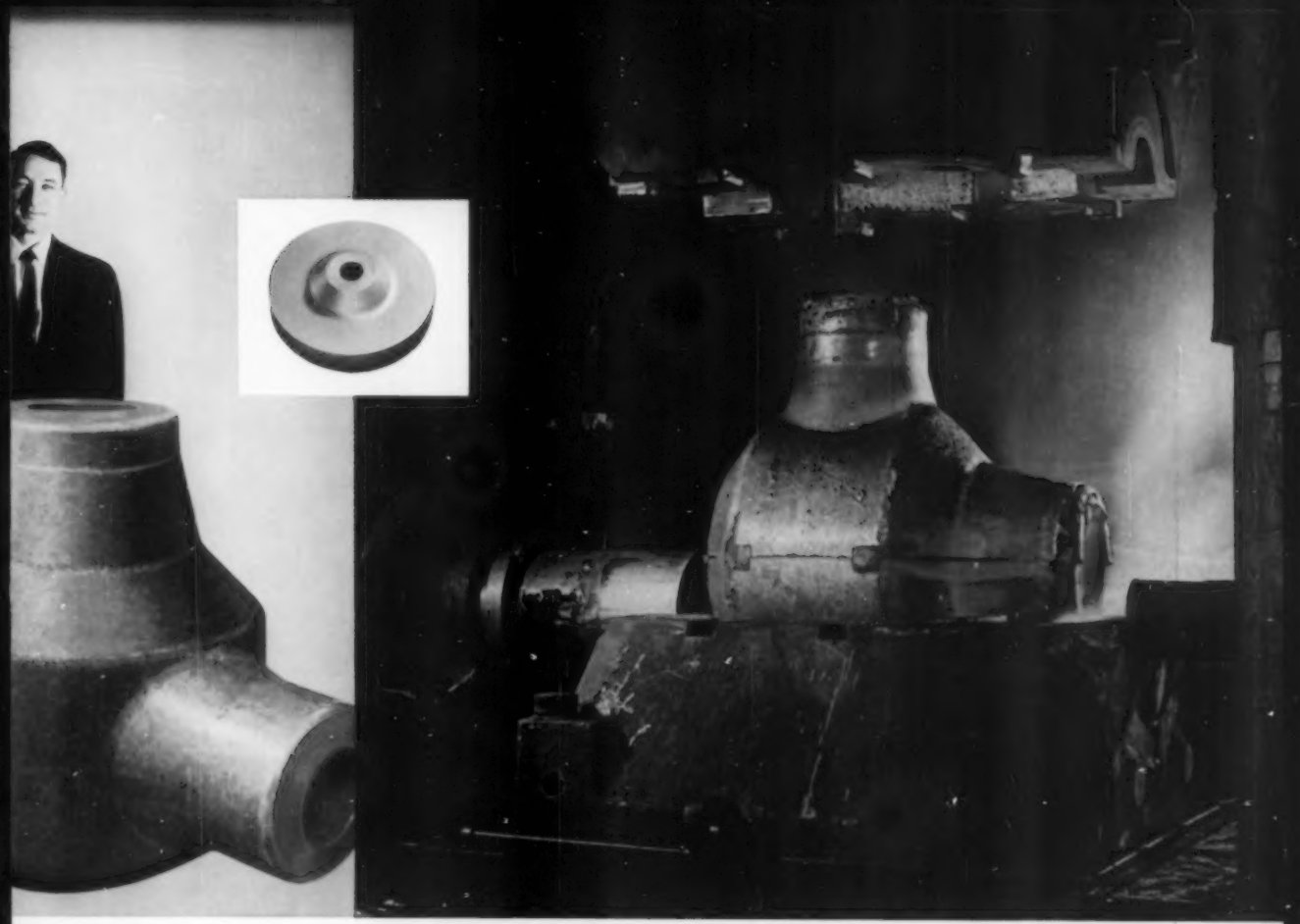
Fairbanks, Morse

A MAJOR INDUSTRIAL COMPONENT OF FAIRBANKS WHITNEY CORPORATION, NEW YORK

No other manufacturer makes pumps for such a variety of hydraulic applications as Fairbanks, Morse. If it's liquid . . . if it flows . . . we make the pumps that move it . . . at low cost per gallon . . . in sizes from 200 gph to 800,000 gpm, and to 3000 psi . . . for every industrial need.

Our pumps . . . our generators and controls . . . our new rotary compressors . . . our drive toward better ways to de-salt ocean water . . . the potential of our advance Research & Development Center in Beloit . . . our lead position in the field of Hydrodynamics . . . all of these equip us to serve you.

Send for our brochure—"Hydrodynamics." Please write to Mr. Robert W. Kerr, President, Fairbanks, Morse & Company, 600 South Michigan Ave., Chicago 5, Illinois.



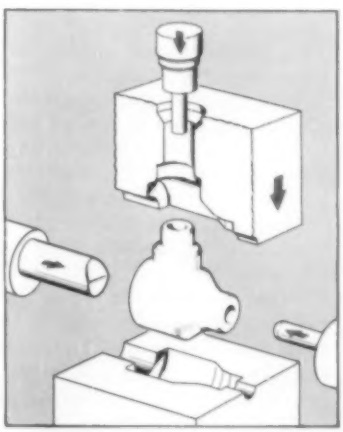
CAMERON FORGINGS

New properties – new quality for new design demands.

Cameron split die ferrous forgings have now been produced for more than a decade – a very short span in the ancient art of metal forming, but just in time to fulfill and stimulate new demands in an age which has made the greatest demands in the history of metallurgy. Our processes and forgings have no exact counterpart in previous forging practice. The 13,000 pound throttle valve body of chrome moly material, photographed above as it emerges from its split die in one of our side ram presses, is a typical Cameron solution to a recent problem, requiring large size, unusual shape and top quality.

The inset photograph gives an idea of our range in size and shape while producing the same superior properties. This jet engine turbine wheel, A-286 material, weighs about 13 pounds, but is one of today's most demanding applications for a precision member.

Large or small, our forgings possess unusual metallurgical properties because:



1. Cameron techniques allow intricate shapes to be forged in one heat, yielding uniformly high properties from center to surface and uniform fine grain size.

2. The movement of metal under high internal pressure increases the transverse ductility properties several times above normally expected values.

3. The internal working of the metal breaks up segregated material inherent in the center of steel and high density alloys and yields forgings that consistently meet high ultra-sonic standards.

4. The totally enclosed method of forging avoids flash line magnetic indications and the localizing effect of the flash grain on transverse, fatigue, and stress rupture properties.

If you specify or purchase ferrous high density alloy or refractory forgings and would like more information about our facilities, write, call or come by . . .

Cameron

IRON WORKS, INC.

SPECIAL PRODUCTS DIVISION

P. O. Box 1212, Houston 1, Texas

OZALID NEWSLETTER

NEW IDEAS TO HELP YOU WITH ENGINEERING REPRODUCTION AND DRAFTING

Standard materials, plus new thinking, result in big time and cost savings.

How to break the halftone costs barrier

Some of the sharper repro men looking to cut the high cost of using halftones in quantity have come up with this little timesaver that goes for pennies per halftone. Here was the problem: 200 rush copies of 16 technical photographs were needed for a service manual . . . a total of 3200 prints. This job would usually run about $2,000 and take ten days . . . that was too long and cost too much.

A bright lad thought about their Ozalid whiteprinting equipment and worked out this procedure: First an 8" x 10" screened film positive was made by projection from a 4" x 5" negative, emulsion away from emulsion. This insured proper orientation of the print in the final stage.

Next, the film positive and Ozalid black-line plastic-coated paper (105SZ) were processed in an Ozalid Printmaster 810 at a rate of 12 feet per minute. The 42-inch width of this machine permitted two operators to work simultaneously, cutting total production time virtually in half! The choice of Ozalid paper Type 105SZ was an excellent one. It gave crisp, black-line images of great density due to the paper's plastic coating. The entire project took just under a fast six hours instead of the usual ten days, and cost about $100.

Total savings: $1900 and 9½ days of production time. Pretty smart, we think. By the way, we've got sample packages available for the asking that might very well give you the same dramatic results. Why not write us at Ozalid, Box DD-4, Johnson City, New York. We'll be glad to help.

Looking for a fast case of the blues?

The happy kind, we mean. The clean, rich, decisive blue image that Ozalid's new Super-Speed Blue-Line (200SS) gives. And when we say fast, that's exactly what we mean. *Poor originals are copied up to ten feet per minute faster than with regular copy papers.*

This is the first Ozalid copy paper specifically designed for copying semi-opaque originals at higher speeds . . . at no sacrifice of line density in any sense!

But what does all this mean in practical benefits, other than increased production at no loss in quality?

Well, for one thing, it means that you can now do a fine job on semi-opaque material, such as one-sided letters, documents and bulletins, at the lowest cost of any copying process . . . even if they're printed on bond papers!

Another benefit is the clean, readable copies you can now produce from soiled, yellowed documents and low-translucency materials much faster than ever before.

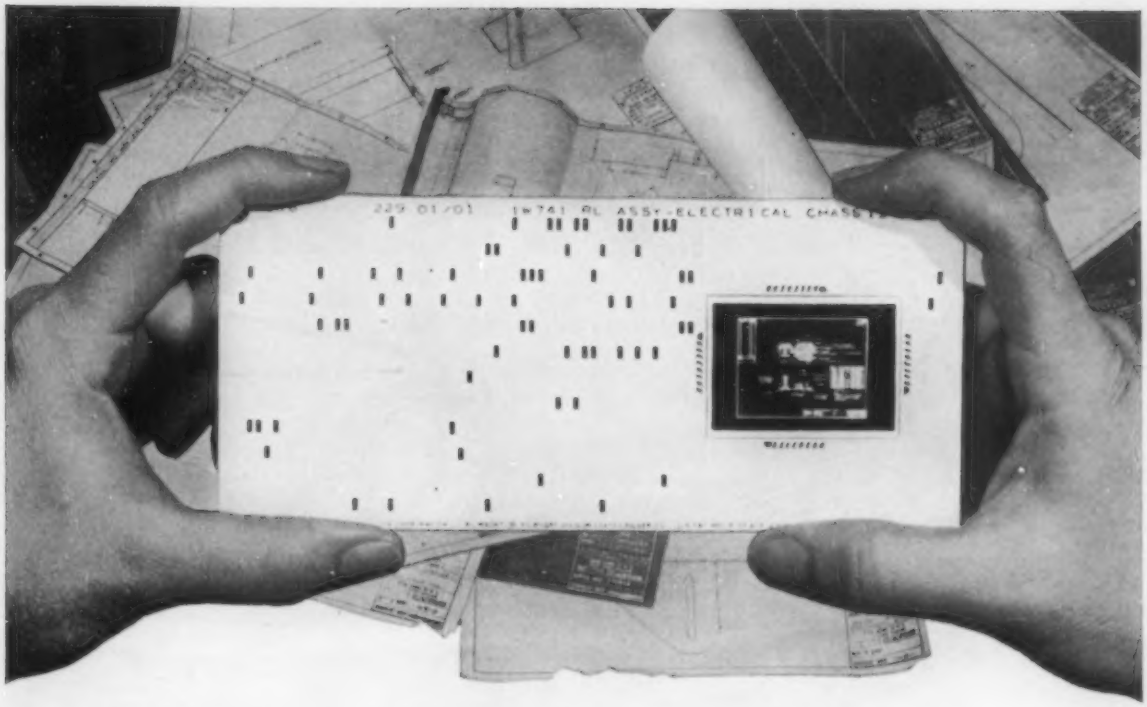
Is that all? Not by a long shot. 200SS actually turns low-powered ultraviolet machines into pretty fast units. And the faster printing speeds mean faster return of the original after each cycle.

Why not try this superb, high-density blue-line paper today? It really makes sense. Just call your local Ozalid representative for a demonstration.

***Ozalid**—Division of General Aniline & Film Corp. • In Canada: Hughes-Owens Co., Ltd., Montreal*

←CIRCLE 59 ON READER SERVICE CARD

CIRCLE 60 ON READER SERVICE CARD



All the accuracy of original drawings but none of the "headaches"

New RECORDAK Precision Drawing System reproduces your drawings as needle-sharp images with remarkably uniform backgrounds on low-cost 35mm RECORDAK microfilm.

Mounting these frames in Filmsort aperture cards provides an *active* drawing file that speeds reference, cuts printmaking costs, ends drawing wear-and-tear.

With decks of cards instead of bulky drawing files, you'll save time *every time* you refer to drawings, and when you need prints. Drawings can be kept at the finger tips instead of "far away"—instantly available for viewing in a Recordak film reader.

This greatly reduces need for reference blueprints. And it makes reference, itself, so much easier. For your microfilmed drawings stay clean and sharp—no smudging or loss of detail from handling or printmaking.

Easy to get paper prints and duplicate film copies

When, for any reason, you do want paper copies, reduced-size prints can be made fast—directly from the microfilm aperture card—by low-cost photographic, xerographic or electrostatic methods. Duplicate "microfilm cards" also can be made for branches, vendors, government agencies for pennies apiece.

Free booklet gives additional facts on this Recordak system available through Recordak and its nation-wide dealer organization.

MAIL COUPON TODAY EE-4

RECORDAK CORPORATION
415 Madison Ave., New York 17, N. Y.

Gentlemen: Send free booklet describing new RECORDAK Engineering Drawing System. No obligation whatsoever.

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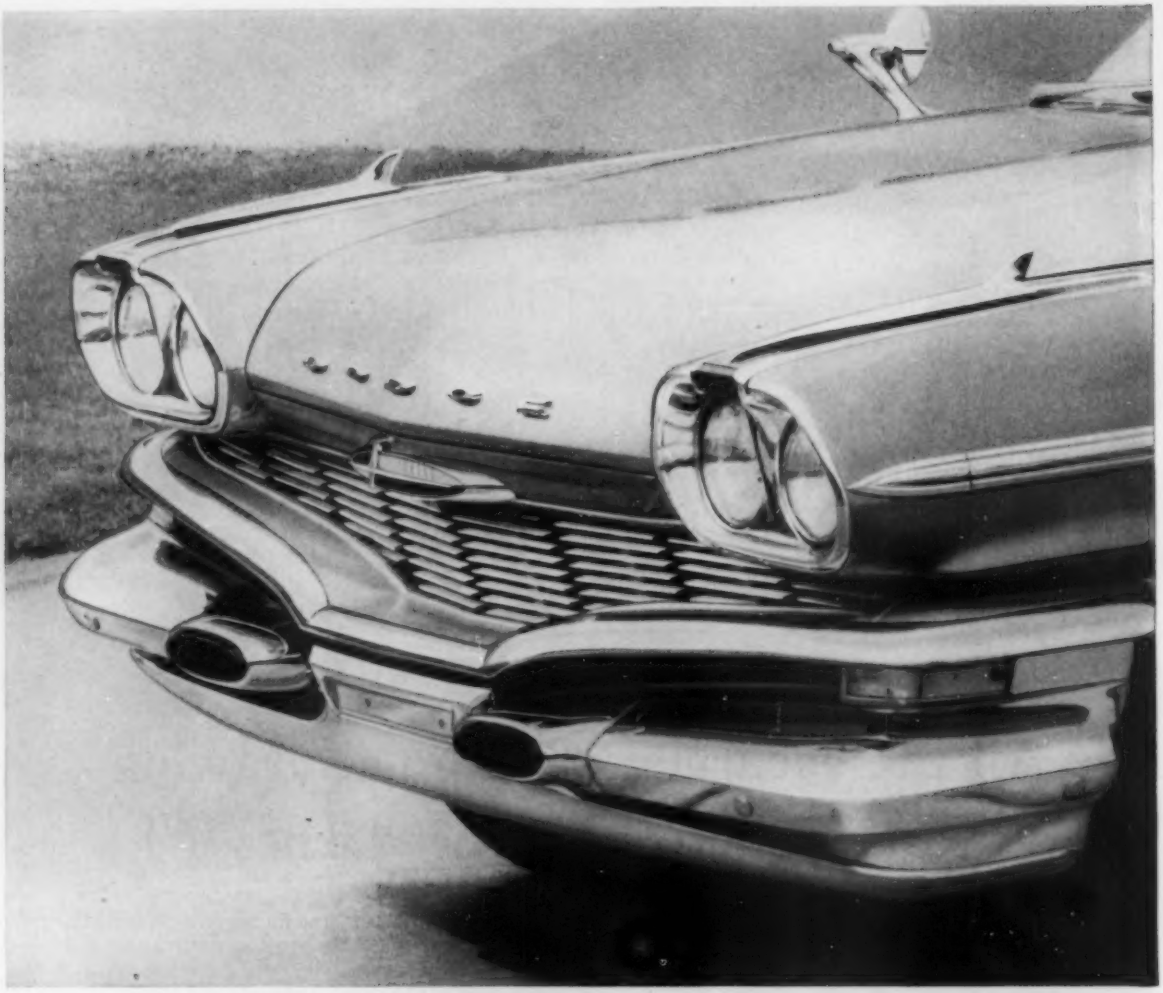
RECORDAK®
(Subsidiary of Eastman Kodak Company)
originator of modern microfilming
—now in its 32nd year

IN CANADA contact Recordak of Canada Ltd., Toronto



Double-Layer Nickel Plating—bright, new way to get lasting beauty in a metal finish

Long will her trim stay bright and shiny! For under that mirror-like topcoat of chrome on the 1960 Dodge there's a double layer of Nickel Plating.

That's right! Not one, but *two* layers of Nickel under the chrome. The first is a layer of semi-bright Nickel to provide a leveling base, a smooth metal foundation. The second is a fully bright layer to provide the lustrous base needed for a gleaming chrome finish.

It's the double layer of Nickel that actually makes possible the lasting brilliance of the finish. You see, double-layer Nickel Plating works two ways: It acts as a cushion against stone or gravel nicks, traffic scratches and abrasions, exhaust fumes and de-icing salts. What's more, it shields the basis metal against rust and corrosion.

It's truly "The Finish of Lasting Beauty". So rich and lustrous, it's bound to earn an appreciative nod from the new car buyer . . . so durable and practical, it just naturally adds to a car's trade-in and resale value.

With Nickel in ample supply, now is the time for you to look into the advantages of double-layer Nickel Plating. Plan to use this quality finish to put an I-want-it gleam into the eye of every car buyer — *and to keep it there!*

For information on corrosion testing of plated coatings and how it can help assure the quality of Nickel-Chrome finishes, write for our booklet, "Corrosion Testing of Electrodeposited Coatings". It's yours for the asking.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO Inco Nickel... *makes plating perform better longer*

PRODUCT ENGINEERING **HORIZONS**

April 18, 1960

LOG ROLLING OR LOG SITTING?

Several commenters (Mar 28) on our "Crackthrough" editorial (Mar 21) guaranteed long forward leaps in research if more money were forthcoming. That's a familiar American solution to any problem . . .

But in this case it isn't true.

Ideas cannot now, and never could be, bought off the shelf. They come because an idea man sees a need, not because he sees a dollar sign. Ideas are, in fact, stimulated by adversity. Arthur Bronwell, president of Worcester Poly, said it in the *Journal of Engineering Education* for November, 1959:

"There are those who say that fundamental research is not supported financially and that this is the cause of retardation. But the roots of the difficulties, I believe, are much deeper. This has been borne out by my observations as an advisor to one of the principal agencies of government dealing with research. It soon became apparent that most of the proposals, even those in the fundamental sciences, although they had elements of originality, were well within the popular research clusters . . .

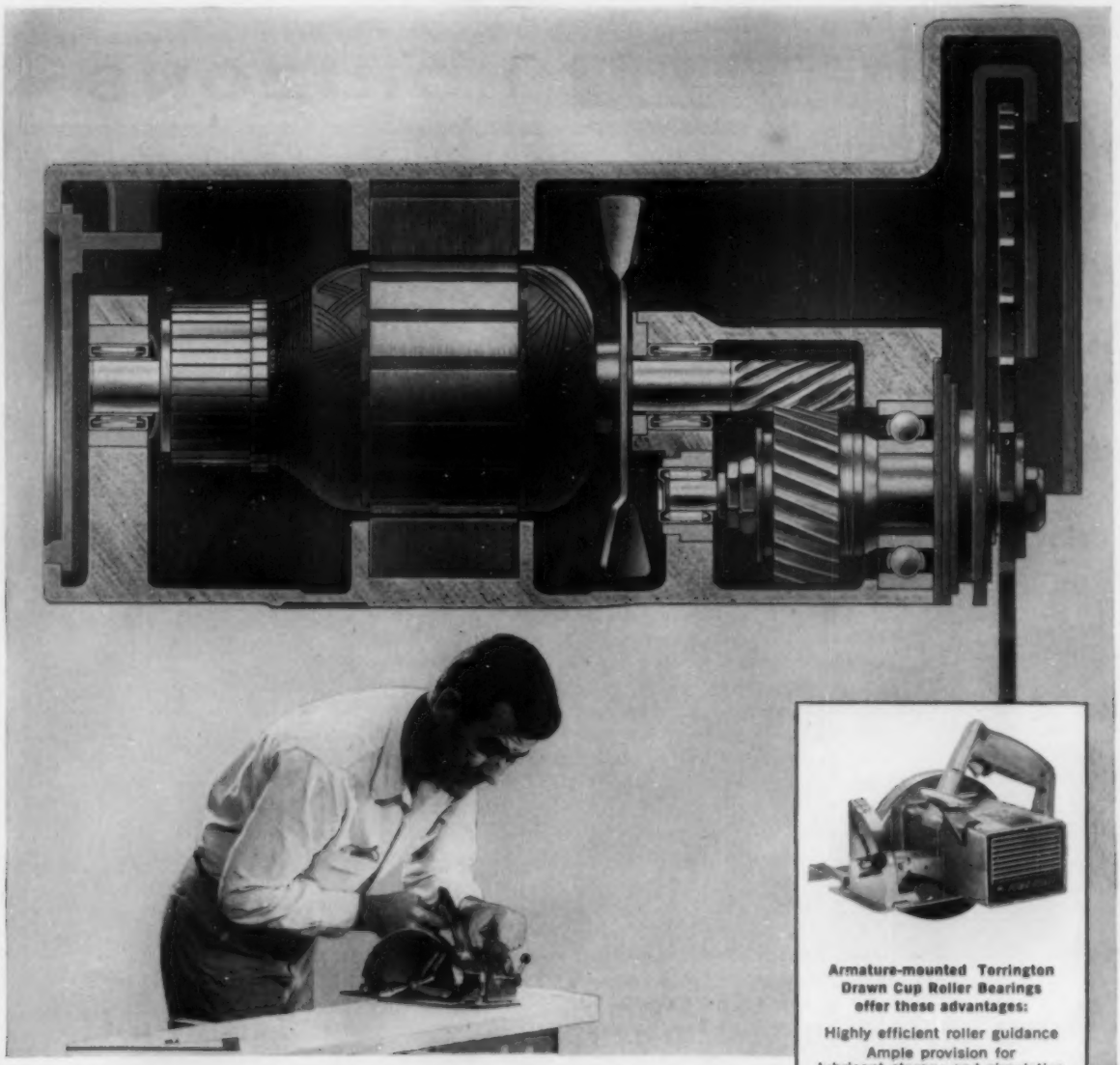
"No, the difficulty basically is not money. Its origins, I believe, are in the communication of ideas. It is the passing on of philosophical ideas and inspiration from those on the one hand who are immersed in the research frontiers and prolific with ideas and, on the other hand, the young research individual who is groping in the dark, earnestly trying to find something different and important and promising to work on, but who will probably fall by the weight of gravity into a conventional field of research. If we could just find an effective link between these two, we could start far more of our young research people on the road to truly significant discovery—and we won't have to worry about money—it will be forthcoming."

Said James A. Garfield in 1871 about the true teacher: "Give me a log hut with only a simple bench, Mark Hopkins on one end and I on the other, and you may have all the buildings, apparatus and libraries without him." Remember that Socrates taught Plato and Plato taught Aristotle, who in turn taught Alexander the Great—they passed a philosophical torch from hand to hand like a Greek relay team—and came up with a general. Said Dr Bronwell on this point:

". . . there is no organized forum where research scientists and engineers can deliberately explore the future in a philosophical sense—no place to captivate the vision and the imagination of youth with new ideas which might trigger some of them off to great discovery. Almost everything presented at meetings of the scientific and engineering societies is past tense. A researcher completes a study and reports on this at a scientific or engineering society meeting, after which it is duly published in the society journal. With rare exceptions, there is no attempt to project into the future philosophically, and one who indulges in this kind of excursion may find himself regarded as a charlatan."

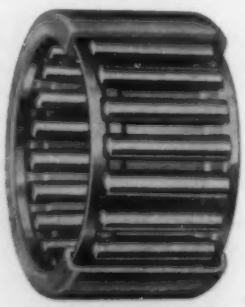
What we need is a chance for the creative mind to talk to the open mind, for more log-bench sitting and less log-rolling, for a Greek-style forum where a man with ideas can express them. One way is to start a new society (American Rocket Society, Nuclear Society, Institute of Aeronautical & Space Sciences, Society of Carbide Engineers, Assn for Computing Machinery). The other is to provide a forum in print, as we on PRODUCT ENGINEERING have tried to do for you.

R. Langeman



Armature-mounted Torrington Drawn Cup Roller Bearings offer these advantages:

- Highly efficient roller guidance
- Ample provision for lubricant storage and circulation
- High capacity in small cross section
- Long pre-greased service life
- Outstanding efficiency at high speeds
- Easy mounting by press fit
- Simple housing design
- Low unit cost



Performance plus for power saw armatures with Torrington Drawn Cup Roller Bearings

Armatures of Montgomery Ward's high quality Powr-Kraft Saws are equipped with two Torrington Drawn Cup Roller Bearings for efficient high-speed operation and long pre-greased service life.

The highly effective roller guidance and outstanding lubrication provision are made possible by the one-piece, shaft-riding retainer design of these bearings. The result is added years of extra-smooth starting and cool running.

The drawn cup outer race construction offers outstanding advantages in compactness, light weight, simple straight-bore housing and easy press-fit installation... important factors in high volume power tool and home appliance applications. Yet improved design and construction make these bearings available at remarkably low cost. In many cases, Torrington Drawn Cup Roller Bearings have lowered armature bearing costs by as much as 50%.

Power saws, drills, electric mixers, vacuum cleaners...all types of appliance motors and generators can benefit from the efficiency and low cost of Torrington Drawn Cup Roller Bearings. For advice on specific applications call on Torrington — makers of every basic type of anti-friction bearing.

progress through precision **TORRINGTON BEARINGS**

THE TORRINGTON COMPANY Torrington, Conn. • South Bend 21, Ind.

for small parts . . . ZINC DIE-CASTING CUTS COST

The inexpensive single-cavity method, with finishing tools built into the casting machine, gives up to 300 parts per minute and tolerances as close as ±0.0005 in. It's best suited when maximum size of the part is 1½ in. and minimum run is 100,000 pieces.

JOHN J McDERMOTT
Manager, sales engineering
Gries Reproducer Corp
New Rochelle, NY

Diecastings may be your best buy in the miniatures field. If zinc is able to carry the loads, small parts made by the single-cavity method can be the answer to cutting production costs.

This automatic process offers consistently high dimensional accuracy and low cost in production quantities—usually 100,000 pieces minimum. Single-cavity casting gives tolerances as close as ±0.0005 in., and its short solidification times produce finished parts at rates as high as 300 pieces per minute.

Secondary machining and assembling, done right in the casting machine, give undercuts and other shape intricacies that otherwise would require retractable cores that add to costs. These cores become impractical as parts get smaller.

Pros and Cons

Advantages of this high-speed process over competing methods—stamping, cold-heading, screw machining and multicavity die-casting—are derived from casting the small parts in a single cavity. The single impression improves part-to-part consistency. And because parts are small, dies are rigid and leave only a thin line of flash on the part; a built-in trimming die takes care of the rest.

The single cavity permits built-in tooling for secondary operations. These operations include choice of trimming, cutoff, turning, spinning, upsetting, reaming, tapping, countersinking, and such assembly steps as staking and riveting.

Casting gives wider choice of shape. Where a cast shape combines several parts, the cast assembly can have better over-all tolerances than assembled individual parts because it does not build up cumulative tolerances from the assembled parts.

The process does have two main limitations:

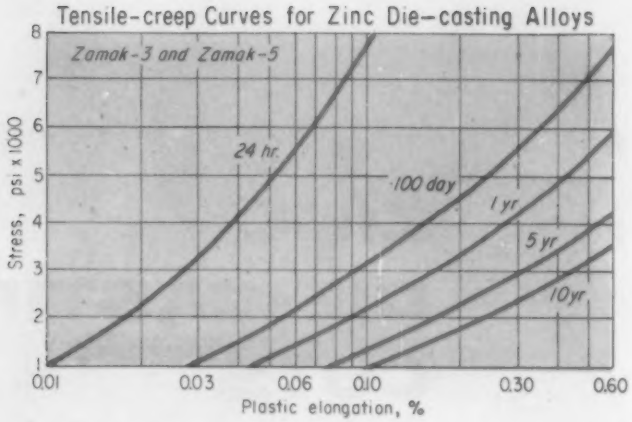
- Size of parts is limited to maximum dimension of 1½ in. or maximum weight of ½ oz. For a 1½-in.-dia part, this means a thickness limit of about ⅛ in. When parts exceed this volume limit, longer solidification times slow production.

- Quantities must be large enough to justify tooling. Production runs under 100,000 pieces generally are impractical. For some standard items like gears or fasteners, stock tooling can make shorter runs economical.

Designing the Parts

Design stresses for die-cast zinc, unlike for other materials, are not found from yield strength. Zinc creeps at room temperature, so stresses must be determined from creep curves by first finding maximum elongation allowable and time under loads. Curves on top of next page give tensile-stress limits for times up to 10 years.

text continued next page



Modifications for Cast Gears and Threads

GEARS AND PINIONS CAST TOGETHER. For light loads, these zinc die-cast gears show little wear. Round flange added to small gear, lower right, lets trimming die cut simple round shape instead of gear profile.

PARTIAL THREADS explain why these diecastings are simpler and cheaper to make. Separating the threads can be done by splitting the part or by specifying flats on both sides at the parting line.

Tolerances (next page) vary with size and weight of the part. One or two dimensions with closer tolerances usually can be kept without extra costs. Best tolerance is 0.0005 in., but generally these closer tolerances cost more, particularly on closure dimensions across the parting line, and on related dimensions like hole-to-hole spacing.

Parting-line placement determines dimensional tolerances, amount of flash left on the part, and the appearance. Best mold closure, and therefore best tolerances, can be had by keeping the parting line in a single plane. Costs are also reduced if this plane coincides with some line of the part itself. For example, a cylindrical piece parted on the end would give best closure, but the sides of the cylinder would have to taper. Putting the parting plane through the axis would eliminate need for taper, but would leave a thin flash on the curved surface. Here, specifying a small flat at the parting line facilitates trimming and helps maintain tolerances. For these small parts, a trim line larger than 0.010 in. detracts from appearance.

Draft is normally ½° on each side although ¼° or even less may be sufficient. Taper in holes, another form of draft, should be at least 0.016 in. dia per in. length, or approximately ½°. In specific cases, taper can be reduced to 0.005 in. per in. This slight taper can be considered straight in most applications. Generally, greater taper causes less die wear, with accompanying lower costs. Therefore holes merely for reducing weight and keeping sections thin should taper 30° or more to keep die wear down.

Cast holes can be deeper if cores are supported on both ends. Therefore, holes which go through, when 0.035 in. or larger, can be as deep as 8 times dia, while blind holes are limited to 5 times. For smaller holes, down to the minimum of 0.025 in., depth limits are 4 times dia for through holes, and 2 times for blind holes.

Many Shapes Are Possible

COMBINED PARTS eliminate assembly. From left—square motor armature includes core for windings, shaft, cam and pinion; two gears spaced on a threaded shaft; cam cast onto hollow shaft.

DIE-CAST JOINTS can be fixed or movable. Chain, top, and hinge below it have integrally cast, movable joints; bead chain sprocket, left foreground, takes fixed shape after assembly and peening over.

Dimensional Tolerances for Small Diecastings

Part weight, oz	up to 0.1	0.1 to 0.3	0.3 to 0.5
Closure tolerance, in.	0.003	0.004	0.005
Length or width tolerance, in.	0.001	0.002	0.003

Cross-sections must be thin to avoid porosity in the material. Use ribs to reinforce the thin section where stiffness is required. A good rule of thumb is ¼ in., with heavier ribs going up to ⅜. Thick-to-thin sections should have gradual transitions to allow better feeding of thin areas. But usually this is not a problem in diecastings, since there is little difference between thinnest and thickest sections.

Minimum section is generally about 0.020 in. A projecting area in a small casting could have even thinner sections, while sections in larger castings, where metal must flow through to feed other sections, would have to be thicker.

Fillets should be at least 0.010 in. but not so large as to increase the adjacent sections appreciably. These cause heat concentrations that result in unsound metal. Even a slight increase in the fillet size makes a difference in the strength of a part. An example of this is the breaking torque on a bolt, which was increased from 8 to 12 in.-lb when the sharp corner under the bolt head was changed to a 0.015-in. fillet.

Radii at external corners, although not as critical for strength, should be at least 0.008 in. for good finishing. Tumble polishing may nick or peen sharp edges; electroplating, particularly with chromium and nickel, will "tree" or build up at the edge. Also, sharp corners are difficult to fill.

Threads and Gears

Cast-in threads have a No. 2 fit. Instead of the full threads, it is simpler and cheaper to make threads that go part of the way around. These partial threads, with a flat on both sides, allow the dies to be more easily parted and the flash more easily trimmed. Flats should be about 0.006 in. to 0.030 in. below root dia, depending on thread size.

Internal threads, when cast, are more expensive than tapping the threads into a cast hole. Driving self-tapping screws into cored holes is the cheaper alternative to cast or tapped threads. Internal threads, whether cast or tapped, have a larger root dia and therefore a higher pull-out strength than that of the mating male threads. In zinc, this higher strength is sufficient to make the female threads stronger than ordinary steel bolts with the same thread size.

Gears die-cast in zinc are suitable for light loads—under 100 lb per in. of face width. Where small gears cannot be lubricated, mating gears of zinc show a 40 to 80% reduction in wear compared to brass-to-brass and steel-to-steel gear combinations.

Gears and pinions can be cast together in one piece. Further savings result from choosing these gear-and-pinion combinations from standard tooling. Such stock dies give gear shapes that are a modification of the AGMA's standard for fine-tooth form with a 14½° involute. They have an extra clearance on the pitch line and larger root diameters, giving wider tolerances on center distances.

EDITOR'S NOTE: For more on other processes for producing small precise parts, see:

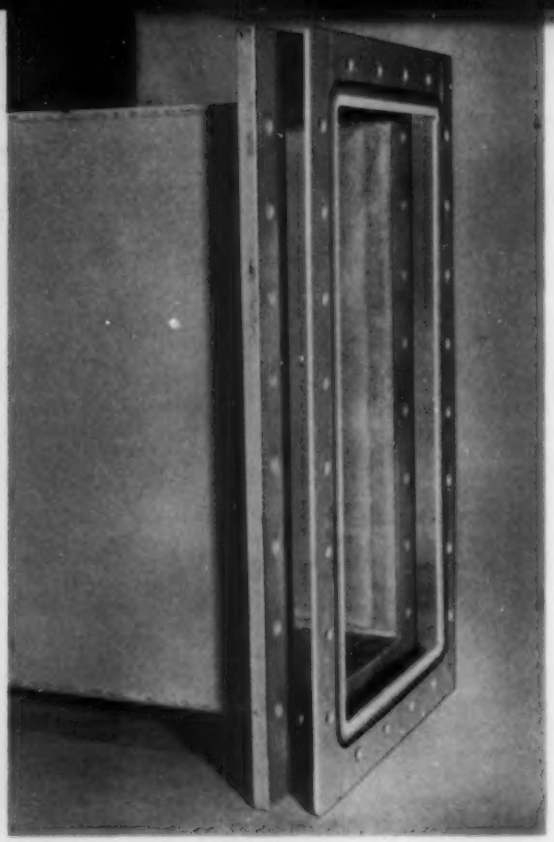
For Tiny Parts—Minicast Does It Cheaper, Feb 1 '60, p 45. Investment casting with plastic patterns allows design to specify high-strength alloys, close tolerances, and fine surface finishes on miniature parts.

Investment Castings . . . Tight Tolerances Can Be Even Tighter, July 20 '59, p 49. Over-all costs go down when castings can be used without finishing steps. Gives ways to handle critical dimensions for lost-wax investment castings.

How to Choose—Investment Casting or Sintered Powder, June 8 '59, p 86. Although investment casting and sintered powder seem competitive, knowing the shape, tolerances and application makes the choice easy.

Electromachining Speeds Its Attack, Mar 2 '59, p 59. Processes that erode ultrahard metals to ultrafine tolerances are coming out of the toolroom to offer new precision for production.

Continuous in-place seal molded directly on both sides of metal spacer.



new development in static sealing . . .

THE IN-PLACE SEAL

This offshoot of the O-ring got its start about 5 years ago by sealing access doors in aircraft wings. Development was kept under military wraps for several years—but industrial applications are now opening up. Here is a guide to typical materials, and a comparison table.

JOHN JORDAN, *research engineer, and*
T J McCUISTION, *vice-president*
Parker Seal Company, Culver City, Cal

About the simplest way to make a static seal is to spread a paste-like viscous-fluid elastomer on the faying (mating) surfaces and bolt them together. This method is generally satisfactory where pressures are low (about 5 psig), temperatures under 130 F, and the faying surfaces not subject to deflections.

On the other hand, when temperatures exceed 500 F continuously, pressures encountered are high, and the fluid being sealed is corrosive and hazardous, only carefully engineered, all-metal seals will work.

THREE BASIC STATIC SEALS

Between these two extremes are the three basic static seals: flat or cork-rubber gaskets; O-rings; and the recently developed molded-in-place seals.

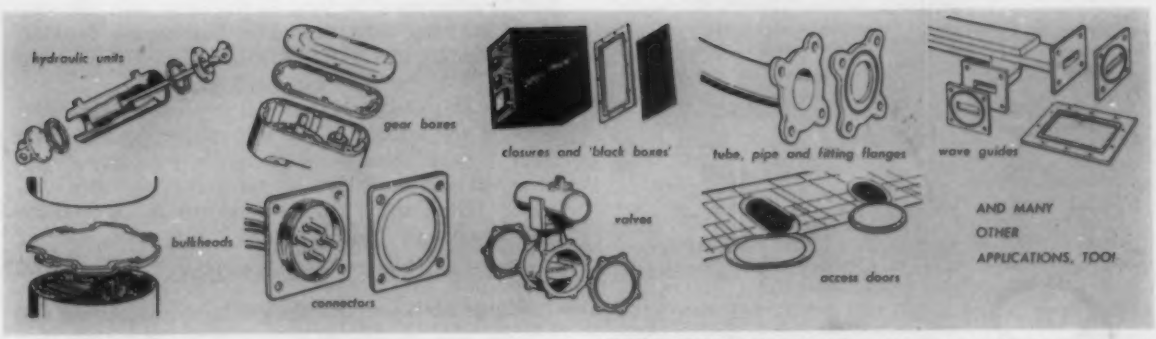
These in-place seals, actually a development of the familiar O-ring, are molded of rubber or elastomeric compound. The molding is done directly in a groove of the metal part—hence, the seal and metal act integrally. The metal can be be a special spacer that is assembled between two mating parts. In such a case, the in-place seal is molded on both sides of the spacer. Or the seal can be incorporated directly on one of the component parts. In-place seals are also being used on the inside of washers for sealing fastenings. Here, however, they are retained mechanically rather than molded in place.

Like gaskets and O-rings, in-place seals are static seals for stationary surfaces, parallel flanges or concentric (non-rotating) cylinders. They differ from ordinary gaskets in that they are designed to be totally compressed in a groove, thus providing metal-to-metal contact between the mating parts.

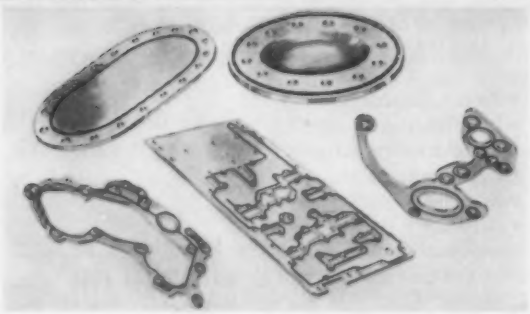
Here are recommended materials for in-place seals, their operating characteristics and a comparison of the seals with gaskets and O-rings.

CHARACTERISTICS OF STATIC SEALS

Static seals are designed to prevent fluids, such as fuel, hydraulic and lubricating oils, water, air, gases and vapors from leaking into or out of a system.



WIDE RANGE of applications (above) results from integral concept of in-place seals. Seals are also adaptable to odd-shaped configurations, (left).



The surfaces they seal are essentially stationary, unlike the surfaces in such dynamic-seal applications as piston rods and rotating shafts. But statically sealed surfaces do move slightly in response to fluid pressure, mechanical loading, and thermal stress. And static seals must be able to maintain a continuous line of contact between mating surfaces in spite of these deflections.

Occasionally, even though the line of contact is complete enough to prevent passage of a high-viscosity fluid under high pressures, a low-pressure gas will leak past because of mating-surface roughness and a lack of plastic flow of the gasket material.

There are many different static-seal designs in use today—the exact choice usually depends on operating conditions and cost.

FLAT GASKETS

Flat gaskets perform satisfactorily where small amounts of leakage are not critical or where flanges can be made extremely heavy to accommodate stresses arising from moderate pressures (up to 500 psig). Stresses in a flange containing a flat gasket are quite complex. It has been demonstrated that a flat, semiresilient gasket, such as one made of asbestos, will produce an increase in bolt loading as the internal pressure of the fluid in a flange increases (see "The Behavior of Narrow-faded, Bolted, Flanged Joints Under the Influence of Internal Pressure," Donald and Solomon, The Institution of Mechanical Engineers, London, 1958).

Conversely, a flat metallic gasket such as copper sheet, will produce a loss in sealing pressure as the fluid pressure is increased. Both of these reactions can result in failure of the gasket to seal. The increase in bolt tension causes bolt elongation or loss of gasket resiliency due to the applied force exceeding the elastic limit of the gasket material. Also, cold flow of flat gaskets and vibration necessitates retightening of flanges, which is common.

In the case of a flat metal gasket, failure occurs through loss of tension on the gasket and deflection of the flanges caused by the internal pressure of the fluid, which rotates the flanges about the gasket. In such a situation the line of sealing contact is easily lost because flat gaskets depend primarily upon the maze effect to prevent fluid from passing between the faying surfaces.

ELASTOMERIC COMPOUNDS

The resilient properties of the elastomeric (rubberlike) compounds allow them to accommodate relatively large deflections of the mating surfaces. Their fluidlike behavior permits them to flow into the fine irregularities of the mating metal surfaces. Yet elastomeric seals will fail under these conditions:

- Insufficient internal pressures to maintain line contact.
- High lateral loads imposed by the fluid pressure. This type of failure often occurs with flat gaskets.

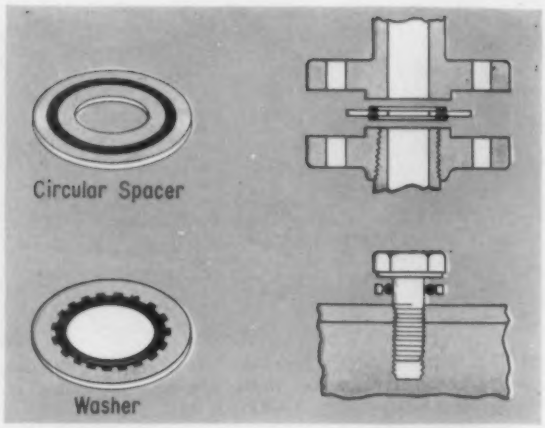
The first problem can be solved by selecting an elastomer with optimum properties for the environment. For the second problem the generally accepted preventative method is to have a more rigid back-up for the elastomer. This confines the seal to an area where it will not exceed its elastic limit, and restrains the pressure transmitted by it. Two principal designs employ elastomeric seals retained by mechanical back-ups: the O-ring-in-groove method and the in-place seals.

O-RING-IN-GROOVE METHOD

This method got its start in high-pressure aircraft hydraulic systems. Here, conventional packings resulted in excessive friction; very complicated, heavy designs; and leakage from overtightening of adjustable packing glands. The O-ring method has been extended to a wide variety of other systems and it is believed to be the principal static-sealing method in use today.

Generally, the cross-section of the O-ring is circular. When it is placed in a groove of a flange and then confined by closing the mating surface, it deforms and partially takes the shape of the confining gland. Resilience of the O-ring material creates a tendency to return to its original shape, thus maintaining a continuous sealing line of contact on all compressed surfaces, even during some motion.

A secondary sealing pressure on the O-ring is supplied



OTHER FORMS of in-place seals: circular spacers for flanges and fittings; washers for fasteners.

by the fluid on the wet or pressure side of the seal. This causes the O-ring to flow or press harder against the faying surfaces and helps maintain a firm line of pressure. O-ring designs are functional from 0 to 4000 psig. and have a temperature range of −65 to 450 F.

IN-PLACE SEALS

These preshaped elastomeric seals are molded directly into the metal groove. The molding usually takes place at the seal-manufacturer's plant. The manufacturer also machines the groove to conform to the mold. If one of the many available standard-mold designs is selected, tool charges are avoided. Shown above are four mold sizes.

As with O-rings, in-place seals respond to the secondary sealing-pressure effect as the fluid displaces the rubber in direction of the faying surfaces. Also, if the elastomer is under less-than-optimum compression, leakage can occur. But in-place seals have better control of the amount of squeeze to the rubber than do grooved O-rings. According to military and commercial specifications (see MIL-P-5514C and Parker O-ring Catalog 5700), rubber-to-void ratio (volume of rubber in relation to total groove cavity area) of O-rings varies considerably and is quite low (74% for the 0.70-cross-section O-ring, 62% for the 0.139 cross-section). The ratio is kept low to avoid, through tolerance stack up, the possibility of more rubber in the groove than the groove can accommodate (remembering that rubber deforms but is fairly incompressible). An excess of rubber will be unsupported and will blow out much the same as a flexible flat gasket.

In-place seals, however, have a much larger rubber-to-void ratio—94 to 99%. Exact amount depends upon the particular compound. If the optimum is used, it is called "controlled confinement," and results in a superior seal. For example, a given compound will seal at a temperature of at least 25 F higher if it is used in controlled confinement. In a small groove this relationship needs proper contouring and dimensioning of seal and groove.

A "third sealing force" results from the lateral squeeze which takes place with good in-place design and practice. The rubber is supported on the sides and does not have an opportunity to flow out under pressure and temperature; consequently, more stress is kept at the line of contact. Furthermore, as there is very little void, the elastomer does not swell excessively and become "tender" (lack of tensile strength). Thus, nibbling extrusion is less of a problem, even with high-swell fluids.

Strips of metal with elastomer in-place seals on both sides are also available. This strip can be cut by using a miter box, and butted end to end to form any desired shape, to give a positive seal around complicated contours. These strips can be employed in combination with round spacers (see illustration at left).

COST COMPARISONS

Because all in-place-seal designs involve machining and molding, they are likely to be more expensive initially than flat gaskets or O-rings, especially in small quantities. But there are other factors to be considered when making up a cost analysis:

- Preparation cost
- Installation and assembly cost
- Anticipated service
- Replacement cost
- Reusability
- Reliability

These factors are compared in Table I for the three different types of seals. The table shows that, while the original cost of a flat gasket may be low, it may require more frequent replacement and is subject to blow-out. The O-ring-in-groove also has a favorable original cost, but requires a closer tolerance groove and longer installation time. Generally, in-place seals are cheaper to assemble and inspect (you can't leave one out), provide metal-to-metal contact, and are reusable.

SEAL MATERIALS

Elastomers have a wide range of capabilities that vary with the type of polymer—and type of compound for a particular polymer. Table II gives only the broad parameters of elastomers—individual call-outs may have to be based upon the special requirements of the fluid system.

For example, nitrile elastomers are noted for their fuel resistance, and silicones for their high-temperature resistance. Yet some nitrile compounds have marginal resistance to certain test fuels while some silicones have excellent low-temperature properties (−180 F) but are marginal above 300 F. Quite often an engineer will say "I'll never design another neoprene (chloroprene) seal into a 250-F system. We tried it and the seal failed." But although this particular compound could not meet the service temperature, other chloroprene compounds may have been satisfactory.

TEMPERATURE CONSIDERATIONS

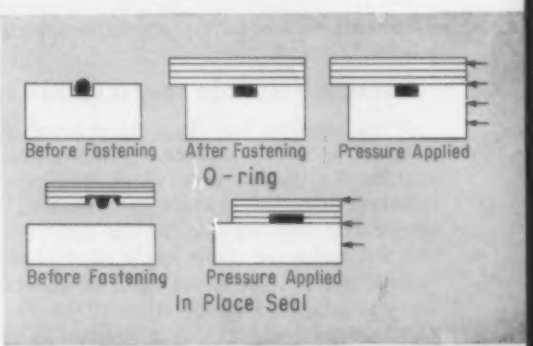
Both the high and low ends of the temperature range are given in Table II—but the actual temperature flexibility of an individual compound depends on what the seal must do. For example, an extremely high-pressure hydraulic seal requires greater resistance to high temperatures than a low-pressure air seal, for the high-pressure seal normally must accommodate greater flange deflections than the low-pressure seal. Effects of high temperatures depend upon time. When the exposure is of very short duration, the temperatures listed in Table II may be exceeded—a Buna N seal in the blast tube of a rocket satisfactorily seals 2000-psig exhaust gases at 1200 F for 9 seconds, which is the required mission life.

Table I—Three Methods of Static Sealing: a Comparison

Points of Comparison	Gasket	O-ring in Groove	In-place Seal
ORIGINAL COST	Lowest delivered price	Original cost favorable	Highest of the three
PREPARATION COST	Requires fairly smooth machined surfaces. Studs, fastening nut and flange must be sufficiently strong to withstand 4000 lb of pressure to each bolt (amount necessary to compress gasket sufficiently to seal). This usually requires ⅜" studs which are higher in cost. Generally, much heavier construction is necessary in order to hold this gasket.	Groove and O-ring must be matched perfectly. Also, flat surfaces of groove are necessary to obtain a satisfactory seal. This results in rather high cost of machining the groove. Also, better finish needed—33 rms now being called out for groove and mating part versus 125 rms on mating surfaces of flat flanges for in-place seals.	No special machining necessary—just reasonably flat smooth faces. Requires thinner flanges and fewer bolts or studs.
COST OF INSTALLATION	Gaskets fairly stiff and easy to handle; installation not too difficult from standpoint of handling.	O-ring very flexible and requires time to place in the groove. Difficult to keep in place during assembly of parts.	One-piece integral component. Easy to assemble.
ANTICIPATED SERVICE	Varies; is sensitive to vibration	Excellent	Excellent
REUSABILITY	May last only half as long as in-place seals. Not reusable.	Favorable. Can be reused in many cases.	Reusable—hence length of service is doubled or tripled, which results in considerable saving.
COST OF REPLACING PART	Some gaskets require resurfacing or cleaning of faying surface. In establishing overhaul periods, this may be such a short time as to upset an overhaul schedule. Loss of productive time of machine during downtime.	Flanges must be widely separated or taken out of alignment to remove old ring, clean groove and install new O-ring. Adhesives may be required to hold O-ring during assembly.	Very little cleaning necessary, and may be replaced without excess operation of flanges; easy to handle.
RELIABILITY	Fair	Good	Excellent

Table II—Resistance of Elastomers to Fluids

Elastomers	Temperature Ranges, °F (Low)	(High)	Fluid Resistance
Buna N (nitrile)	− 80 to −10	160 to 300	Excellent oil & fuel resistance.
Neoprene (chloroprene)	− 65 to +20	212 to 350	Fair oil resistance, good water and steam, excellent ozone resistance.
Butyl	− 80 to −50	160 to 275	Very low gas permeability excellent resistance to phosphate-ester-based hydraulic oils.
Natural (rubber)	− 80 to −65	160 to 275	Excellent resistance to water and water-soluble materials.
Silicone	−180 to −65	300 to 500	Good in phosphate esters, hot air, alcohols; fair to poor in hydrocarbon fluids.
Viton A	− 65 to +10	375 to 450	Excellent resistance to hydrocarbons, fuels, disebacate ester, lube oils (A/C turbines), siloxanes, silicate esters, and other high-temperature hydraulic oils.



UNFILLED VOID in O-ring groove permits undesirable shift under pressure; in-place seal configuration is carefully chosen to fill 94 to 99% of void.

In considering a particular sealing design, time at temperature should be known. The most refined procedure is to estimate the normal operating temperature with the required operating life, also indicating the lowest and highest operating temperatures to be expected. The chart on next page gives estimated life expectancy of high-pressure seals.

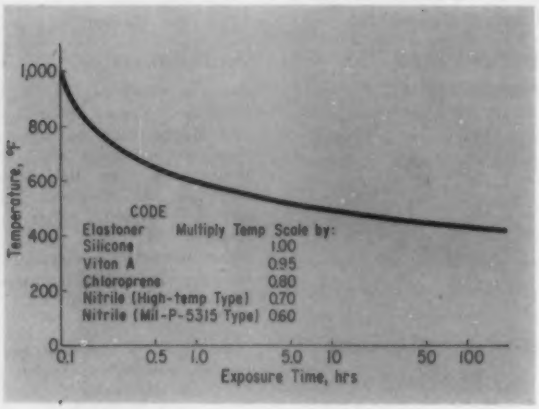
The combined effects of the fluid and the elevated temperatures are often overlooked. There are some silicone rubbers that are resistant to temperatures as high as 600 F, and are resistant to jet-engine lubricating oil at room temperature. However, these same materials immersed in this oil at 300 F will completely dissolve.

EXPANSION-CONTRACTION CHARACTERISTICS

Elastomers expand at a rate approximately ten times that of steel; consequently, if the high temperature of a system is maintained, the line of contact will be preserved by the expansion effect beyond the times given in the chart. Thermal expansion is also a major factor in seals

Table III—Linear Thermal Expansion of Typical Elastomer Seals Compared to Common Engineering Alloys

Material	Linear Shrinkage, in./ft, +75 to −65 F	Linear Expansion, in./ft, +75 to +375 F	Coeff. of Expansion, in./in./°F
Nitrile	0.104	0.224	6.2×10^{-5}
Chloroprene	0.128	0.273	7.6×10^{-5}
Viton A	0.130	0.277	7.7×10^{-5}
Kel-F	0.140	0.300	8.3×10^{-5}
Silicone, general purpose	0.170	0.363	10.1×10^{-5}
Silicone, extreme low temp	0.173	0.370	10.3×10^{-5}
Silicone, extreme high temp	0.183	0.392	10.9×10^{-5}
Aluminum-17S-T	0.022	0.047	13.0×10^{-6}
Stainless 302	0.016	0.035	9.6×10^{-6}
Mild Steel	0.011	0.024	6.7×10^{-6}
Invar	0.001	0.002	6.0×10^{-7}



LIFE EXPECTANCY of seal materials as affected by operating temperature.

for use in extremely low temperatures, because the elastomer tends to contact at a greater rate than the metal mating surfaces. More than the minimum squeeze or compression and the required resiliency should be designed into a seal, otherwise the continuous line of sealing contact will be lost from low-temperature shrinkage of the elastomer. Table III compares the thermal expansion-contraction characteristics of some typical elastomers that are used in seals.

METALLIC SEALS FOR TEMPERATURE EXTREMES

When long-term seal life at temperatures above 450 F or below −100 F is required, an alternate to elastomeric seals are the metallic seals, which have some degree of resiliency. Generally speaking, the required resiliency is obtained by designing into the seal assembly a configuration that makes use of the spring effect of metals. Some metallic seals use the spring effect of stainless steel tubing, plus additional sealing stress at the line of contact imposed by the squeeze that is imparted by retainer rings of dissimilar metals (metals having different rates of thermal expansion). As the temperature increases, the inner retainer expands at a rate greater than the outer retainer. Differential in expansion rates causes the metal O-ring to be squeezed laterally, creating a displacement in the normal directions.

Obtaining sufficient resiliency to accommodate flange, thermal, and stress distortions is half the problem. It is still necessary to obtain plastic flow of the seal into the surface roughness of the flange to get a gastight seal by coating the metal seal with a high-temperature-resistant plastic material. The plastic by itself is not sufficiently resilient to effect a seal; but, backed up by the spring action of the metal seal, it accomplishes the necessary plastic flow. Teflon coating is used for this purpose from −410 F to +650 F. Above 650 F metal plating is used, which is less plastic and requires better surface finishes. Upper temperature limit of present metal seals has been established at 1200 F using Inconel-X or similar materials.

AMBIENT TEMPERATURE CONDITIONS

Frequently, the fluid temperature in the system is a great deal higher than the temperature of the seal, because the seal generally is in an area where the temperature is reduced by heat radiation. By attaching thermocouples through a small hole in a flange to the seal itself, it has been found that exhaust gases at 1400 F raised the temperature of the seal after five minutes to only 300 F. In another case, a steam line at a constant 350 F caused a temperature increase at the seal to just 300 F. Thus, engineering estimates of temperatures are usually high, and static seals are often overengineered. This causes material compromises that are unjustified and often represent a negative factor in an otherwise satisfactory design. When specifying a seal material, state fluid to be sealed, normal operating temperature range, life expectancy.

EDITOR'S NOTE: For additional articles on seals see:

How to Apply O-rings, Aug '57, p 176. Shows how selection of O-rings depends upon physical and dimensional characteristics of the application.

Four Types of Synthetic-fiber Felt, July '57, p 178. Gives mechanical and chemical properties and how they are related to their effectiveness as seals and gaskets.

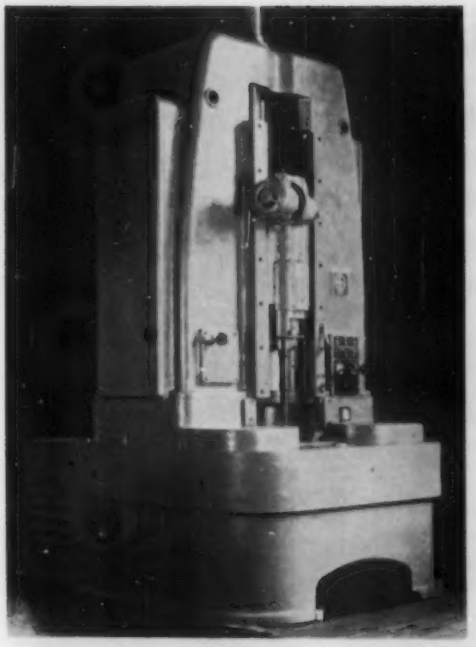
These Gaskets Are Sprayed On, Oct 14, '57, p 90. Describes a technique of sprayed-aluminum gasket for large-flanged openings in tanks, bulkheads and piping.

O-ring and Gland Design for High-temperature Seals, Jan '56, p 151. Discusses factors affecting the design of glands for sealing reciprocating or rotary motion under extremes of heat and pressure; requirements for seal material, gland design, lubrication, loading and surface finish.

Rotating Seals for High Pressure, Feb '56, p 140. Sketches and design data show effect of hydraulic balance, structural design, packing and seal face materials on selection of rotating mechanical seals for severe operating conditions. Tells how to minimize demands on individual seals by controlled flow and pressure distribution.

For Lower Die Costs —Controlled Forging

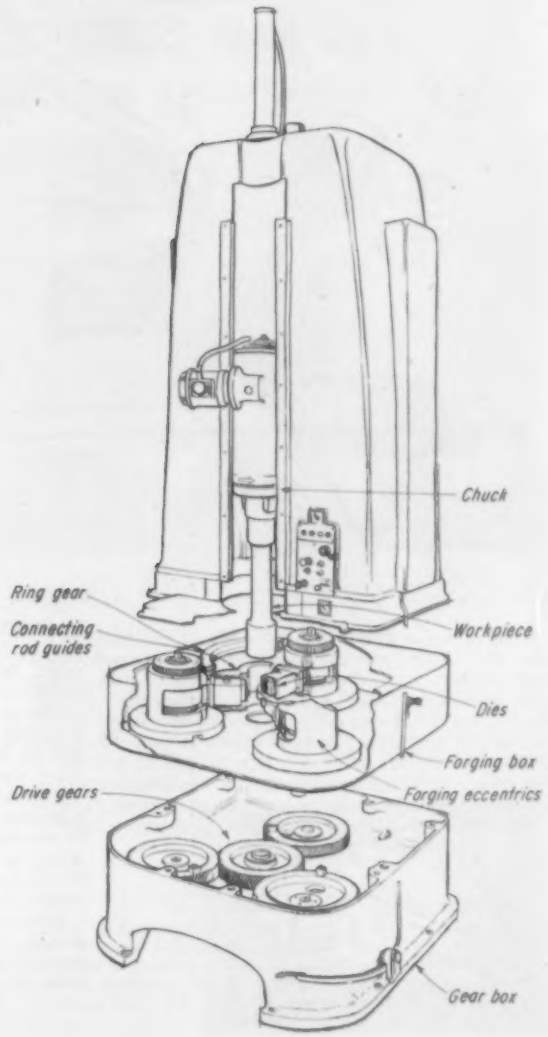
Adjustable system enables same dies to produce a variety of forged shapes. Its dimensional accuracy reduces stock lost in final grinding or turning operations, and speeds operation.



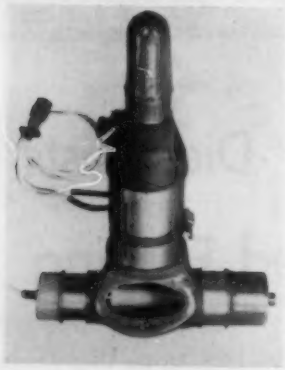
FORGING BOX contains three eccentrics, which transfer their motion through connecting rods to the forging dies. Motion of the eccentrics is synchronized, so forging blows are in equilibrium and the foundations of the machine are unaffected. Bearings for these eccentrics are mounted in separate housings rotated by a second set of eccentrics with an externally toothed ring gear altering radial distance between bearings and the machine centerline. This adjustment permits variations in diameter of the workpiece.

Forging dies are oilcooled and the connecting-rod guides are watercooled to accelerate heat transfer from dies and forging. Preset hydraulic controls provide: radial setting of forging hammers to give the workpiece the desired diameter; vertical movement of the chuck for the desired height; interconnection of radial settings and vertical movement of the chuck to coordinate the shaping of tapers and steps.

As many as seven different lengths and diameters can be produced on one workpiece by means of stops on the control drums. Templets combined with the stops are used to produce tapers or other shapes that may be desired.

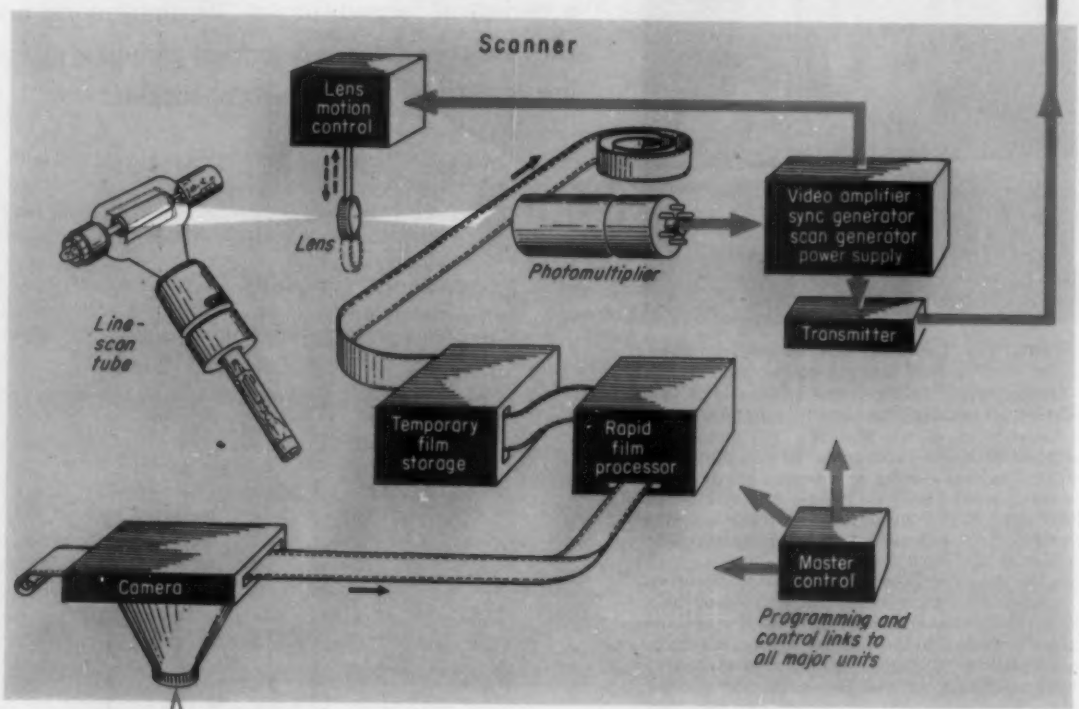


PS . . . Machine was developed for round forgings but, with special dies, will also handle concentric shapes such as splined shafts and polygons. Tolerance of ±0.008 in. can be held for hot-forged steel shapes from 40-60 mm dia. Forgings up to 1100 mm long and 90 mm dia can be forged with a maximum forging pressure of 100 tons. Model SFR362 forging machine is produced by Gesellschaft der Ludw. von Roll'schen Eisenwerke AG, Bern, Switzerland.



Vacuum Bearings Use Solid Lube

Dry-lubricated ballbearings are for rotor encapsulated in high-vacuum cathode-ray tubes; stator is externally mounted. Rotating phosphor-coated drum replaces conventional screen, eliminates phosphor burns and overheating.



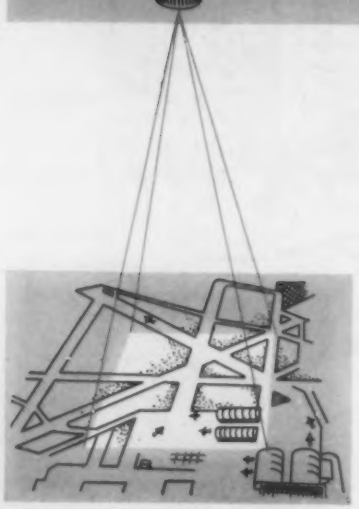
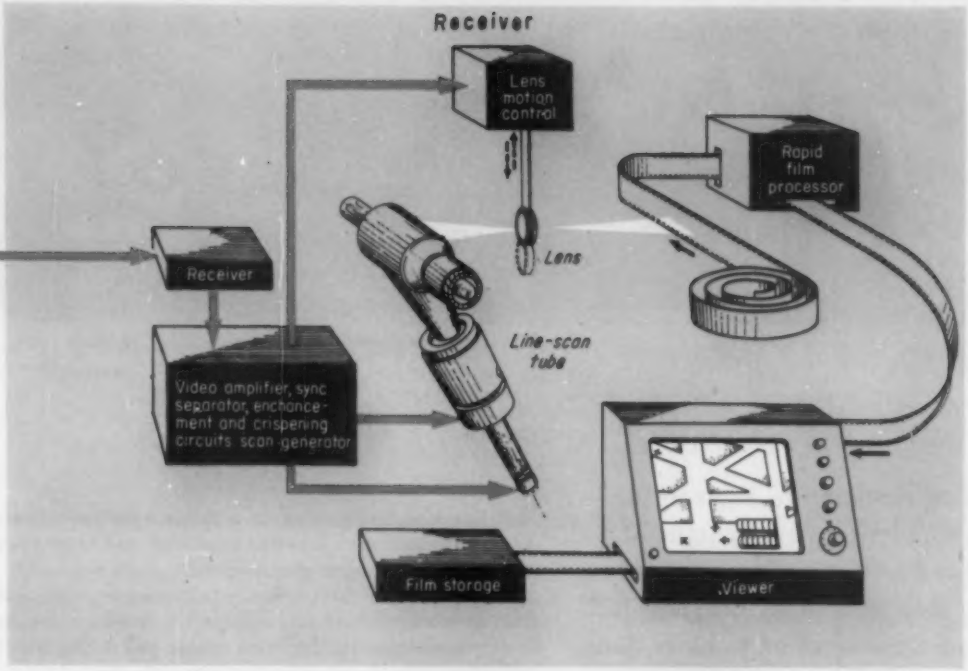
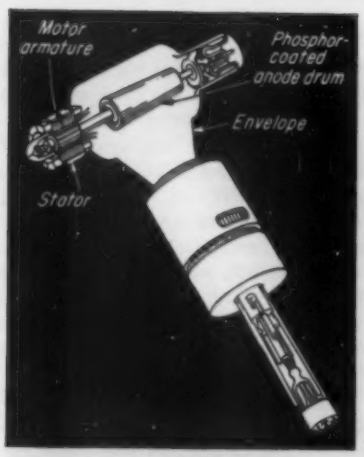


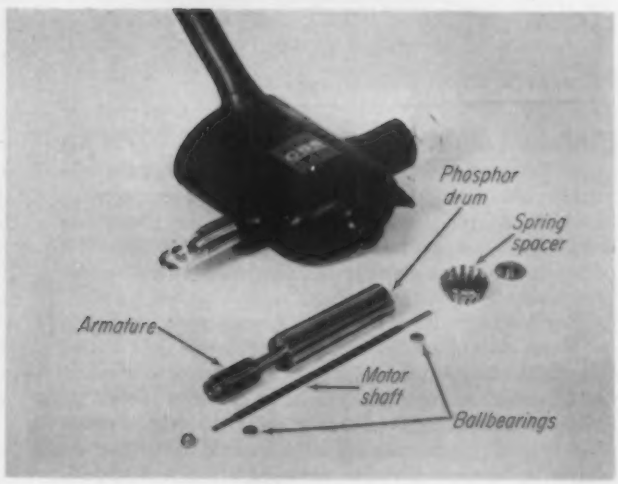
IMAGE-TRANSMISSION SYSTEM incorporates two line-scan tubes—one in the airborne scanner, the other in the ground receiving equipment. In the scanner tube, an electron beam continuously reads or scans a line on a rotating phosphor target. The luminous line this produces is focused on the developed film by a moving lens. Result is a rapidly traveling spot of light that is modulated by density of the film as it passes through. The varying light flux is converted into a video signal by a photomultiplier tube.

Standard electronic techniques convert and transmit the signal to a ground receiver. The line-scan tube in the ground receiver writes or records the signal transmitted from the scanner. The final video signal is used to modulate the line-scan tube's electron-beam current. The intensity-modulated light spot is focused upon the film and, as it moves, the original film image is reconstituted.

After final processing, the film is ready for viewing, evaluation and storage. The time interval between data acquisition through the scanner and display of the same data at the base receiving station can be reduced to 30 seconds depending upon the specific mission.







LINE-SCAN TUBE has a phosphor-coated anode drum that spins at 1600 rpm and is driven by an external electrical field. Rotor is located on shaft of the drum, within the evacuated glass envelope. Liquid lubricants would vaporize in such high vacuum. This required the development of a dry lubricant for the ballbearings that support rotor and anode drum. Such lubrication provides the bearings with a life in excess of 1500 hours.

Several features of the line-scan tube eliminate streaking of the reproduced image and provide improved definition:

Irregularities in the phosphor surface are reduced by electrodeposition of the phosphor coating on the anode drum. Rotation of the drum produces a random screen pattern, eliminating continuous streaks common in ordinary tubes. Heat created by the electron beam is rapidly dissipated over the entire drum, preventing burned spots or streaks in the phosphor coating. Increased efficiency and elimination of halo effect are achieved by direct generation of light on the phosphor surface. A larger percentage of light generated by the electron beam is utilized.

PS . . . Electronic information-processing and transmission system permits long-distance transmission of high-resolution images obtained from photographic or other sensing devices. Data can be transmitted from an aircraft or missile directly to a distant ground receiving station or through a relay station for instantaneous display and storage on film. Giving detail obtainable by the most advanced photographic equipment, transmitted pictures have definition in excess of 10,000 lines—compared with 500-line resolution of television. Photoscan is produced by CBS Laboratories, Stamford, Conn. Div. of Columbia Broadcasting System, Inc.

WHERE DO YOU FIT IN?

Here's a sort of roadmap to engineering—how a product moves from department to department (or function to function), what each group of men adds to an idea, how it is expressed, and what kind of work is done at each step.

RICHARD M KOFF, *Assistant managing editor*

When your friends ask what you do for a living, do you say, "Engineering," and quietly tiptoe away from the subject? And when your son says, "What's engineering, Daddy?" do you duck behind high-sounding generalities and hope he'll forget he asked? For that matter, could you describe what you do to a colleague—and have you the courage to be honest?

Engineering today is like a tightly coupled railroad train in which each of a series of specialized departments makes its contribution and then passes the project on to the next group down the line. The interesting characteristic is that while the sequence is relatively inflexible (the separate jobs must all be done, and in a fixed order) the individuals can be as mobile as they like, changing function from project to project or even staying with a single project through several of its stages.

Basic Research

This is also called pure research to emphasize the devotion to knowledge rather than specific application. The government sponsors much of the basic research done today. While it is not the exclusive preserve of college or university laboratories and research foundations, it is pretty nearly so—industry is generally too product-oriented to permit economic justification of research expense. Notable exceptions are Bell Labs, and the largest companies in electronics, aeronautical and chemical industries.

Basic research finds out what happens under given physical circumstances and, as far as possible, why. The happenings may be unexpected, the theories about why may be wrong, but basic research always contributes a little more organization to scientific knowledge and often opens windows to areas never even suspected.

The product of basic research is literature—papers, articles, discussion letters—and talk, in the hotel lobbies and conference rooms, in the lunch rooms and during society meetings. The literature is mined by other researchers and by product-hungry companies.

Feasibility

This is sometimes called applied research or preliminary design. The idea for a proposed new product is examined from all angles. Marketing tries to find out if there are enough customers and how much they would pay for it. At the same time feasibility engineering asks, "Can it be made to work at all?"

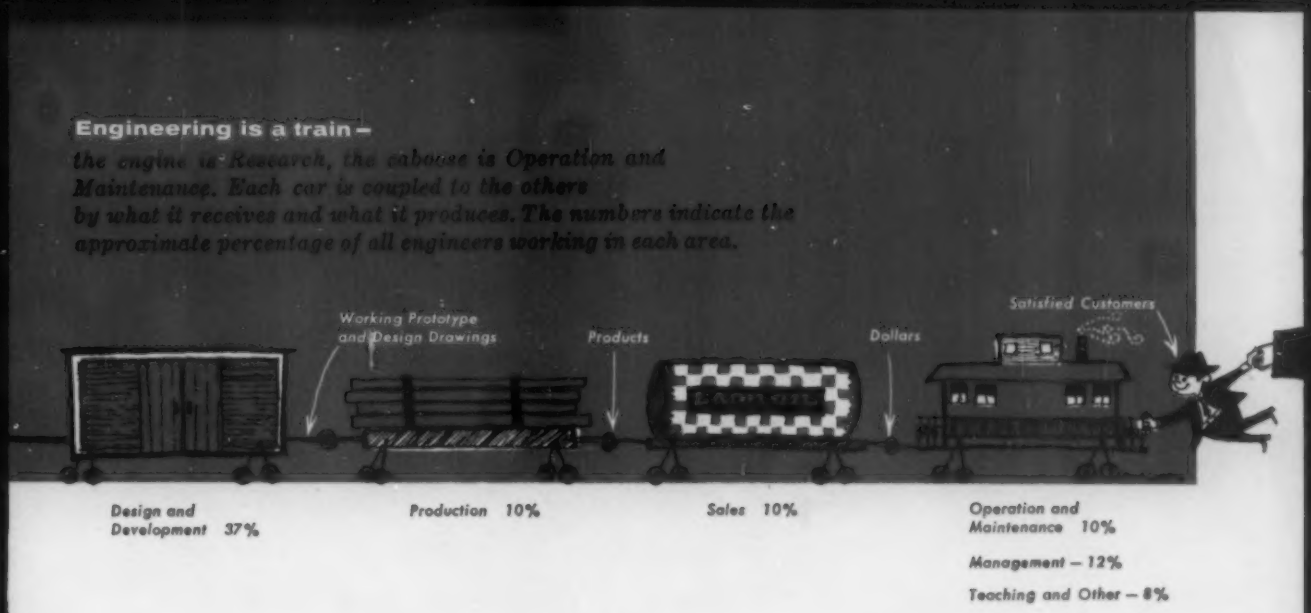
Note the switch in emphasis here: the basic researcher is knowledge oriented, the applied researcher is product oriented. He starts with a statement of the problem and must suggest a solution "in steel." He combs the literature for answers, suggests or commissions intensive study if there are no answers ready. He'll do the work himself if he needs it or believes in it enough.

The atmosphere is theoretical and analytical—preliminary design is, of necessity, "blue sky" and speculative, but practical results are its goal and sole reason for existence. The product of this department is sketches, proposals, breadboard test results confirming the feasibility of the proposed design.

Design and Development

These are inextricably intermingled and the exact sequence may vary from industry to industry. A prototype can-opener can be made in a model shop from rough sketches supplied by the designer who then usually follows through on test, evaluation, and debugging himself. A prototype airplane needs full-fledged design drawings before it can be started in the shop.

In both cases the design-development procedure is aimed at producing a working model—preferably full scale, but not necessarily so. It embodies the principles predicted as workable by the feasibility group and gives management


Engineering is a train—
the engine is Research, the caboose is Operation and Maintenance. Each car is coupled to the others by what it receives and what it produces. The numbers indicate the approximate percentage of all engineers working in each area.
Working Prototype and Design Drawings
Products
Dollars
Satisfied Customers
Design and Development 37%
Production 10%
Sales 10%
Operation and Maintenance 10%
Management — 12%
Teaching and Other — 8%

its first real understanding of how the product will look and work.

Industrial design aspects, that is, appearance and human engineering, should be brought in no later than this and preferably earlier. Industrial design must work closely with the development group and its recommendations and changes will be incorporated in the working model, in the drawings, and in the reports passed on to the next stage.

The design-development group may have produced a full set of detail and assembly drawings ready for the production, but more likely theirs will be a design more suited to model-shop manufacture.

Production Design

If the product is to be mass-produced a small change in material or dimension may make a big difference in production cost. This takes the specialized manufacturing knowledge of the production engineer.

The production engineer looks at the prototype as a problem in manufacture. How can it be made to satisfy all the requirements of design at least cost per unit? Note that the production group is concerned with all aspects of manufacturing and so tool engineering, materials handling, purchasing are all deeply involved.

The one-man production-engineering department does everything from design to production-floor supervision. Larger organizations can divide the responsibilities among several men or groups of men.

Production design makes up a set of detail working drawings, including tool design drawings, recommended feeds and speeds, and full parts lists for purchased parts. The drawings go to the factory floor where the parts are actually made and assembled. Quality control establishes standards and tests to assure consistent meeting of design specifications.

Production engineers act as advisors or consultants to all functions from preliminary design to sales.

Sales Engineering

Industrial products that become components of consumer products or are used to manufacture consumer products take a good bit of engineering for proper application. The specifications and performance data are listed in catalogs and bulletins. But the sales engineers who know their products well and can talk the engineering customer's language are application engineers much more than they are salesmen. Sometimes considerable versatility and ingenuity are required to make a more or less standard component serve all the varied needs of diversified users. So the application engineer is in reality doing a kind of preliminary design or feasibility engineering limited only by his imagination and, of course, the limitations of the components being sold.

Operation and Maintenance

These may be a division of the sales engineering group —the purpose is to keep the customers happy, and sold. They act as a combined complaint department and fire extinguisher. The maintenance engineer often makes valuable recommendations to the designers whose familiarity with field conditions may be limited.

Management

Where does management fit into this flow? It's not one of the links in the chain, but management decisions pervade every aspect. Engineering management must choose directions for research, establish which products are likely to be most profitable, confer with nonengineering departments, and supervise the transmission of each department's contribution to the next one down the line. Management hires and fires, takes care of physical facilities and generally assembles the series of separate cars into a train having unity and direction.

Where department men tend to be specialists, knowing much about limited areas, management men must be generalists, capable of talking all languages and understanding the problems and interests of the many different contributors to a finished product or to a successful business.

EDITOR'S NOTE: Other articles on where and what engineers contribute:

Engineering Organization in Transition, May 11 '59, p 47. A major staff survey of all phases of engineering and R & D organization.

Can We Get More Engineering Per Engineer? Sep 21 '59, p 32. How to free engineers from time wasters.

how practical is NONLINEAR PROGRAMMING?

Though considered rather highbrow by most engineers, nonlinear programming is still the only way to crack many familiar problems. Here's an introduction and some simple but practical examples.

GEORGE F HADLEY
School of Industrial Management, MIT

Of all mathematical programming techniques, the nonlinear type is potentially the most valuable. It can find an optimum solution for a function that has variables subject to definite, but not necessarily linear, restrictions. The function need not plot as a straight line (as with the popular linear programming), nor is it necessary that the problem reduce to a step-by-step procedure (as with the useful dynamic programming). It is the most general of the programming methods—in fact, linear and dynamic are only special cases of nonlinear programming.

The drawback is that solving a problem in nonlinear programming is usually not an easy matter. Even computers that can handle large linear programming problems may be unable to tackle the task of solving a modest nonlinear programming problem. Further, no formal procedure for computation exists.

Some special but useful problems can be solved, however. Easiest way is with the graphic solution. Solutions to other nonlinear programming problems can be approximated by reducing them to linear programming problems.

Graphic Solution, for Two Variables

From linear programming we recall that the problem, when defined in mathematical terms, reduces to two types of mathematical expressions. One type describes the function to be maximized or minimized in terms of the unknown; this is the objective function. The other type (usually several individual functions) limits the unknowns to values within a fixed range, and are known as the inequality constraints. Object of the problem is to find which solution, of the infinite number satisfying the inequality constraints, will give a maximum (or minimum) value for the objective function.

Consider, for example, a simple programming problem. A machine shop can make two products, 1 and 2. Each product must be worked on by two machines, A and B. The number of hours required on each machine for each product, and total machine time available per week, are summarized in this table.

	Product		Time Available (hr)
	1	2	
A	2	3	6000
B	2	1	4000

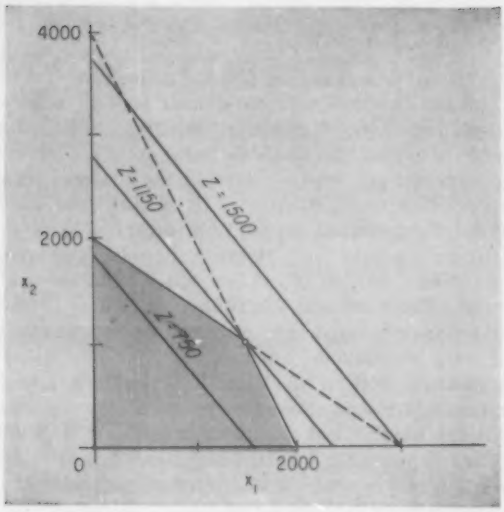
Suppose this were a problem in linear programming, with profit to be 50 cents on each unit of product 1, and 40 cents on each unit of product 2. From table, the constraints are

$$2x_1 + 3x_2 \leq 6000$$
$$2x_1 + x_2 \leq 4000$$

where x_1 and x_2 are the numbers (which must be more than zero) of units of each product produced per week. The objective function gives total profit and is to be maximized:

$$z = .5x_1 + .4x_2$$

This problem can easily be solved graphically. The lines representing the constraints enclose an area between the axes in which the optimum solution must fall. Lines representing various values of z from the objective function are drawn across the graph; largest value of z with some part of the line touching the enclosed area is the desired optimum. The graph at top of opposite page shows how it's done: max profit of $1150 occurs when the machine shop produces 1500 units of product 1 per week and 1000 units of product 2.



With a nonlinear programming problem of similar form, we can handle the situation in which average unit profit on product 1 is not constant, but decreases as more units are produced. This behavior might occur because of quantity discounts, need for more advertising, etc. Assume, for example, that profit received on x_1 units is

$$\left(0.5 - \frac{x_1}{4000}\right) x_1.$$

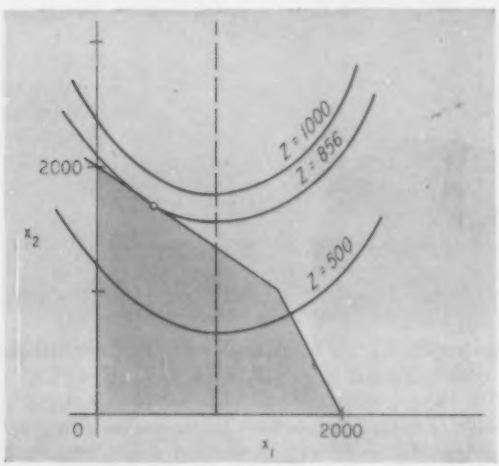
The objective function now becomes

$$z = \left(0.5 - \frac{x_1}{4000}\right) x_1 + 0.4x_2$$

Rewriting the equation in the form

$$\left(x_2 - \frac{4000\,z - 10^6}{1600}\right) = \frac{1}{1600}\,(x_1 - 1000)^2$$

shows that the lines of constant z are now parabolas.



The optimum solution occurs at the point where $x_1 = 467$, $x_2 = 1691$ and $z = 856$. The values of x_1, x_2 can be found analytically by solving for the point where line $2x_1 + 3x_2 = 6000$ is tangent to the parabola.

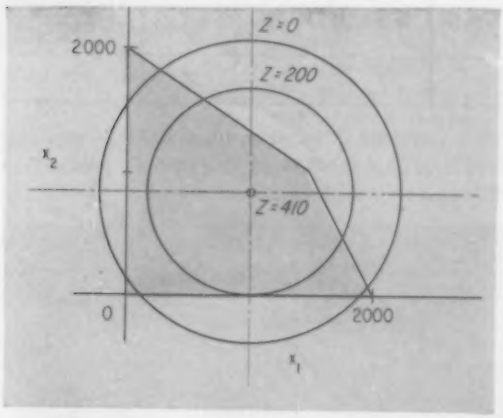
If the profit of product 2 also decreases with amount produced, according to a similar relationship, the objective function becomes

$$z = \left(0.5 - \frac{x_1}{4000}\right) x_1 + \left(0.4 - \frac{x_2}{4000}\right) x_2$$

When rewritten in the form

$$1.64 \times 10^6 - 4000\,z = (x_1 - 1000)^2 + (x_2 - 800)^2$$

it can be seen that the curves of constant profit are circles, with center at $x_1 = 1000$, $x_2 = 800$.



As radius of circle decreases, z increases, reaching maximum when radius of circle is zero. Thus, max profit is

$$z = \frac{1.64 \times 10^6}{4000} = 410$$

and optimum quantities to be produced are $x_1 = 1{,}000$, $x_2 = 800$.

The secret of a formal solution to linear programming problems lies in the fact that the optimum solution occurs at a corner of the boundary. But in nonlinear programming the solution may appear anywhere on the boundary—or even within the enclosed area. Thus, a simple extension of the techniques of linear programming are not suitable for nonlinear programming problems.

More Than Two Variables

It is sometimes possible to find approximate solutions to nonlinear programming problems by converting them to the linear type. Most practical problems have too many variables to be suitable for solution by the graphical approach. Some of these larger problems have nonlinear objective functions which are simply a summation of separate terms with each variable independent of other variables. These "separable" objective functions have the form

$$z = g\,(x_1, x_2 \cdots x_n) = g_1\,(x_1) + g_2\,(x_2) + \cdots g_n\,(x_n)$$

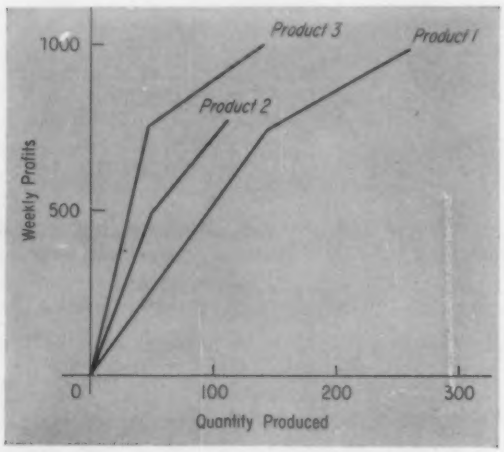
A nonlinear programming problem with separable objective function can be approximated by a linear programming problem if the function is either of two types: In the case of maximization, a smooth, concave curve (decreasing slope) must occur when $g_j\,(x_j)$ is plotted on the ordinate and x_j on the abcissa; or, when minimizing, the curve must be convex.

If the terms of the objective function are neither straight lines nor curves, but segments of straight lines,

the separate linear programming steps will give an exact solution. For example, suppose a small machine shop makes three different products, each product requiring a certain amount of time on two different machines. The number of hours on each machine for each product and total time available per week is:

	Product			Time Available (hr)
	1	2	3	
A	2	1	3	500
B	1	4	2	600

Further, because of quantity discounts, the profit from each product is a function of the quantity produced, as follows.



For product 1, the profit is

$$f(x_1) = 5x_1, \quad \text{when } 0 \leq x_1 \leq 150$$
$$f(x_1) = 750 + 1.5x_1, \quad \text{when } x_1 \geq 150$$

By redefining x_1 as two variables, x_{11} and x_{12}, in which x_{11} is the number of parts less than 150 and x_{12} is number in excess of 150, the profit for product 1 is

$$f(x_1) = 5x_{11} + 1.5x_{12}$$

If all three variables are rewritten this way, the problem reduces to a linear programming problem in which the constraints are

$$2x_{11} + 2x_{12} + x_{21} + x_{22} + 3x_{31} + 3x_{32} \leq 500$$
$$x_{11} + x_{12} + 4x_{21} + 4x_{22} + 2x_{31} + 2x_{32} \leq 600$$

and the objective function

$$z = 5x_{11} + 1.5x_{12} + 10x_{21} + 3.33x_{22} + 1.5x_{31} + 2.5x_{32}$$

When the terms of the objective function are not composed of straight lines, but smooth curves, these can be approximated by straight-line segments. This will not give an exact solution but the approximation can be improved, by dividing the curve into finer subdivisions.

Quadratic Programming

One important class of programming problem has a nonlinear objective function that cannot be divided into smaller segments because variables do not form independent units. Quadratic programming problems have an objective function of the form

$$z = g_1 x_1 + \cdots g_n x_n + g_{11} x_1^2 + \cdots g_{1n} x_1 x_n + \cdots$$

These can be solved with the simplex method of linear programming if, in the case of an objective function that is to be maximized, the quadratic terms, $g_2, g_3, \ldots g_n$, are negative or zero (or, when minimizing, the quadratic terms are positive or zero). Computer codes that solve linear programming problems require only slight modifications to solve the quadratic type. However, a quadratic programming problem with m constraints and n variables yields a linear problem with $m + n$ constraints. Thus, a rather small quadratic programming problem may expand into a large linear programming problem.

A quadratic problem could arise if, for example, a small company that manufactures two products uses the same production facilities and raw materials for both. The selling price of product 1 is \$5 and of product 2 is \$10. But production cost depends on how much of each product is made and is given by the equation

$$C = 2.60 x_1 + 4.75 x_2 - .12 x_1^2 - .05 x_1 x_2 - .08 x_2^2$$

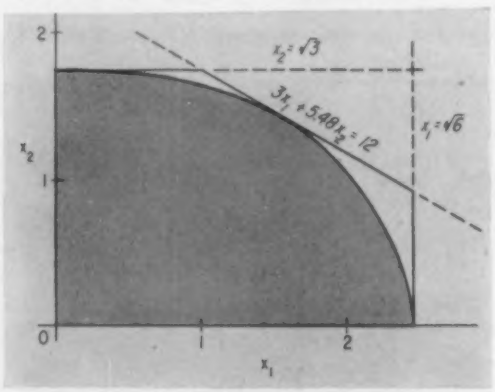
where x_1 and x_2 are units of products 1 and 2 produced per week. Therefore weekly profit is

$$z = 2.40 x_1 + 5.25 x_2 - .12 x_1^2 - .05 x_1 x_2 - .08 x_2^2$$

Because the quadratic terms of this objective function are always negative or zero, the problem can be solved by the quadratic programming method.

Nonlinear Constraints

Very little has been accomplished toward solving programming problems that have nonlinear constraints. In some cases, however, the boundaries of the area described by the nonlinear constraints may be approximated by several linear constraints. For example, suppose one constraint is $x_1^2 + 2x_2^2 \leq 6$, as shown below.



The boundaries can be approximately by three straight lines with equations $x_1 \leq \sqrt{6}$, $x_2 \leq \sqrt{3}$, $3x_1 + 5.48\ x_2 \leq 12.0$. Here, a nonlinear constraint has been replaced by a number of linear constraints. A better and better approximation can be made with more and more linear constraints. But, because a number of linear constraints are needed to replace a single nonlinear constraint, a programming problem with only a few nonlinear constraints can lead to a problem with a huge number of linear constraints. This limits the usefulness of such a technique. ■

ENGINEERING MANAGEMENT

a division of responsibilities

It's a growing source of trouble to top management ("Where are our truly creative men?") and to engineers and researchers ("Dammit, we're professionals, not slaves!"). The area of conflict may be narrowed and controlled by this simple, but effective suggestion.

More engineers keep moving into management. Statistics indicate that the percentage of engineers in management rises from 9% (6 to 10 years after graduation) to 40% (21 to 30 years after graduation), while those in design drop off correspondingly from 37 to 20% in the same period. Yet few men are so ill-equipped by training or temperament for administrative responsibility as are engineers.

The pat answer has been to go to a graduate school of business administration. Now doubts are being expressed about even the B-school. Both Ford Foundation and Carnegie Corp reported recently that business schools are of dubious value in producing executives.* Professor Pierson writes, ". . . capacity for administrative responsibility is chiefly developed through experience, not through academic study." Mr Gordon suggests these basic skills and abilities are necessary for business: analytical ability, judgment, skill in inter-personal relations, ability to accept responsibility to make decisions, general administrative skills, breadth and fertility of mind, imagination, facility in personal communication, strong personal motivation. "Yet," he concludes, "there are relatively few business schools that adhere consistently to these principles in the details of their programs."

How could they? How do you teach such ideals as human wisdom, understanding, and patience? And maybe it's a mistake even to try.

The Lure of Success

Still, lures of pay and prestige continue to woo many research-minded men right out of their natural profession and into the mediocrity of middle management. A division of Union Carbide Corp offered to let any staff member spend 10% of his laboratory time on any project he might want to pursue. The company also offered up to $5000 of equipment. The program produced some fine results—but it has much less appeal than you might think. Actually, UC had trouble getting the men to take advantage of it.

Said one Union Carbide officer:

"The success bug bites our young fairly early in the game . . . although we provide lines of professional advancement parallel to the lines of advancement in the administrative echelons, many of our young scientists and engineers are convinced that only the administrative positions will reward them financially and with prestige in accordance with their ambitions. We take pains to show them that this is not necessarily so, but if they persist and are entitled to a shot at being a member of the management team, we give it to them. Often young researchers are soon disillusioned by this experience and return to the battle to extract nature's secrets, rather than continue the struggle with recalcitrant budgets and the grievances of their subordinates."

Yet management must have technically minded men. The control of an engineering or research group can never be entrusted to the professional administrator whose training is the business school.

Engineers are by nature applecart upsetters. It's their job to improve or replace obsolete present-day practices. Their entire lives are spent in preparing the future—building the products, processes and plants of tomorrow. Administrators, having achieved a successful present, are reluctant to give it up. They would like to point out the areas needing revitalization and build careful walls around them so that the acid of change won't affect other, presently satisfactory, areas.

So, under a professional manager, the engineering group is crushed into submission—it follows the rules and stays on the cement walks carefully laid out by the boss and creates nothing, much to the loud dismay of the manager.

Or Engineering is freed to sniff and taste in all directions, following whim or curiosity, led by a researcher who is more interested in his own particular area of work than he is in what is going on at the other desks of the staff.

Perhaps these alternatives are more extreme than real life, but they suggest a compromise that may be the answer.

Two Bosses Are Better Than One

Why not both? Why not separate the functions of research director or chief engineer from those of VP-research or engineering administrator? Set up two men with different areas of responsibility—one technical, one administrative.

Let the man of budgets, personnel policies, and customer contacts do what needs to be done with all the polish and psychology at his command. Let the engineer with training and analytic ability apply his talents to choosing new directions for study, helping subordinates over tough problems, encouraging original thinking and creative design. He can understand the half-formed, badly expressed concepts of his staff.

Let the disagreements and misunderstandings between Administration and Engineering be confined to these two men. Where their responsibilities overlap, storm and fury will explode—in their private offices. But the work will be done—and well—as long as the engineer protects his staff from management and the manager protects the rest of the company from the engineer. —EJT, RMK

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* *Higher Education for Business*, by Robert A. Gordon & James E. Howell, Columbia University Presss, 470 pp, $3.50, sponsored by the Ford Foundation.

The Education of American Business, by Frank C. Pierson, McGraw-Hill Book Co, 730 pp, $7.50, sponsored by Carnegie Corp.

EFFICIENCY TOOLS FOR DESIGNING AND PRODUCING

3-D HARNESS WIRING

Once the basic circuits have been designed, the author's new technique takes over—with punched cards, mockup, and camera that records final assembly.

PAUL N BEAUCHAMP, *supervisor*
Military Product Engineering
AC Spark Plug Div, General Motors Corp, Flint, Mich

Punched cards are bringing mass production to the custom-wiring field. These coded cards store wiring-harness design information and, when fed to an automatic printer, give concise manufacturing instructions to the wireman. Bulky wiring diagrams are thereby eliminated from the assembly floor.

Then 3-dimensional models (mockups), wired in accordance with the cards, help discover design errors. As a further aid to assembly, a full-size layout is cemented right onto the wiring panel. A photograph of the final harness (like top one on facing page) is a valuable engineering reference, and a useful tool for future production assemblies.

PRELIMINARY WIRING DESIGN

But before starting any wiring plan, you must have good design—basic circuits proved out on breadboards. For best design of such circuits, these tips will help:

Electrical Design Factors

Current-carrying capacity is based on temperature rise and is tabulated in many electrical handbooks for insulated and uninsulated wire, bundled or single strands. Low capacitance is usually desirable, particularly in high-frequency circuits. (Capacitance depends on volume and surface area of wire.)

Noise (stray electrical signals from adjacent components, wires or systems) must be eliminated from circuits that operate at low energy levels—in the millivolt range—where such signals can become stronger than transmitted signals. Shielding, properly grounded, will prevent noise—but at considerable expense in space, cost and assembly time. A better solution is to keep interfering circuits far apart, or redesign to eliminate the problem.

Mechanical Design Factors

Single harnesses can have up to 1500 insulated, unshielded wires. But smaller bundles are easier to handle, and the same 1500 wires, divided into several harnesses, can be worked on simultaneously by several wiremen. Shielding will protect against stray electrical interference but increases bulk, and must be grounded to the chassis.

Square bends and parallel wires improve appearance and make servicing easier. For square bends, each wire must be bent separately as it is laid into position.

Presoldering components to the wiring harness simplifies final chassis assembly. It also eliminates burning, scratching and contamination of the chassis by soldering tools. However, component mounting and spacing must be designed with presoldering in mind: use internal flanging, make chassis openings large enough to pass components.

Careful spacing in final assembly will prevent mechanical interference between a harness and adjacent terminals and brackets that might cut or chafe wires. Good spacing also allows elbow room for assembly, soldering and repairs.

THE NEW METHOD

Once the preliminary circuit design is made, all circuit components and wire sizes must be defined, and over-all dimensions of the chassis given. Then, the new method takes over, following this logical sequence:

1. Make mechanical layout of components on chassis
2. Sketch wiring on mechanical layout
3. Make preliminary harness design
4. Record design data on punched cards
5. Build mockup or harness board
6. Wire mockup, using punched-card data
7. Revise punched cards for improved final design

Steps 1 to 3 are mutually dependent, and should be considered together. This is particularly important when the design is complex or miniature. A preliminary arrangement of components can be sketched by referring to the electrical schematic, a parts list, and drawings of the chassis. Where possible, electrically connected components should be adjacent, wire lengths short. The quantity and sizes of wires in each branch of the harness can then be estimated, and the components shifted where necessary. Harness diameters can be estimated by making sample bundles out of short lengths of wires chosen.

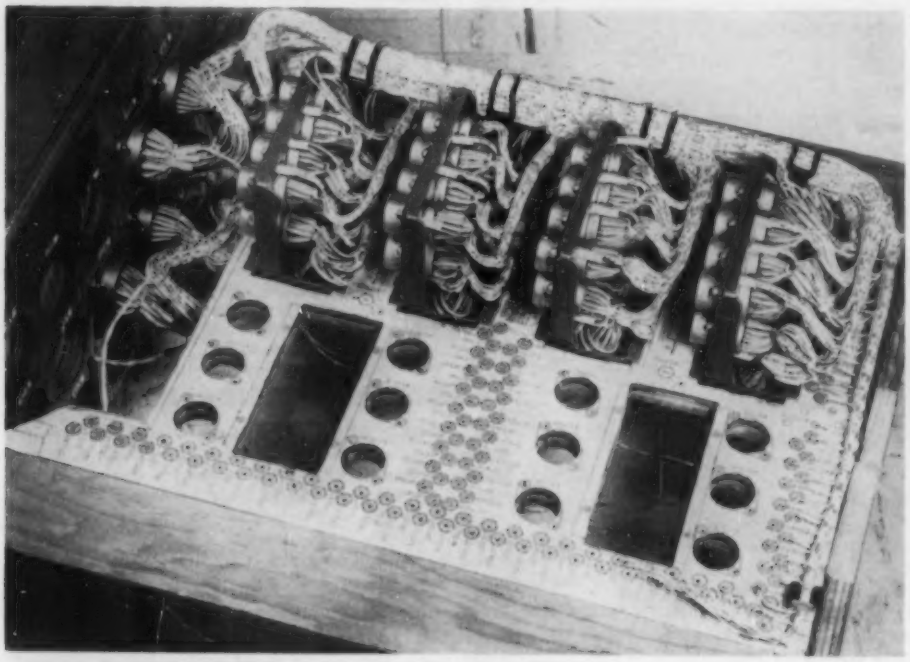
RECORDING DESIGN DATA

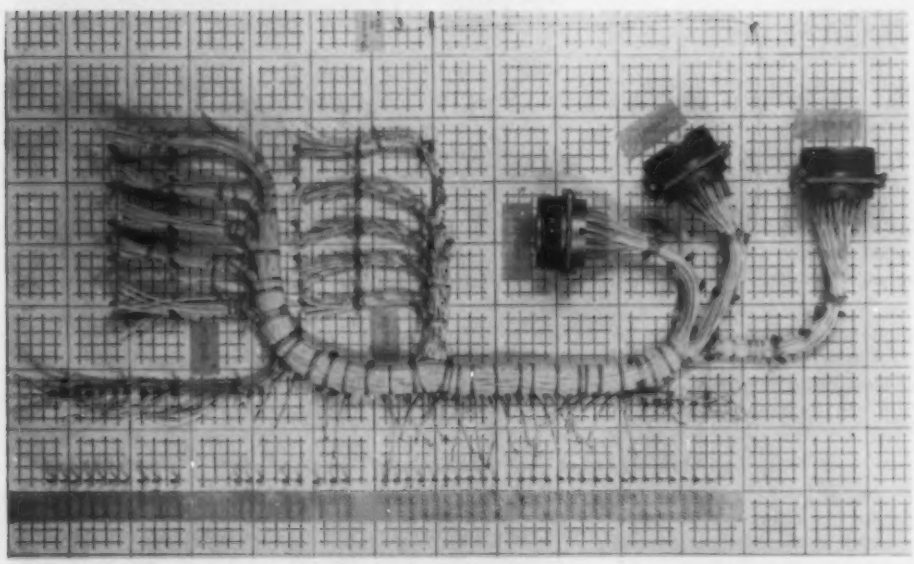
Punched Cards

Punched cards can store most of the decision information important to manufacturing: wire size, type, length,

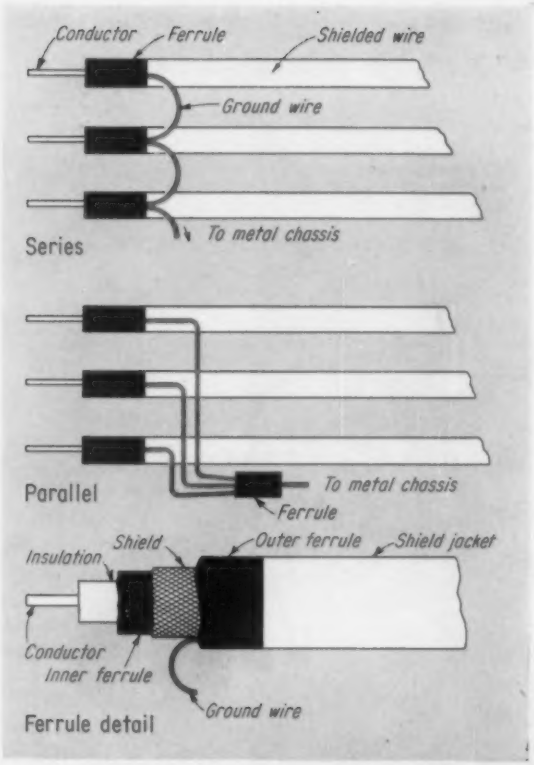
text continued on page 84

THREE-DIMENSIONAL MOCKUP made of plywood simulates actual wired product and is valuable tool for design as well as manufacture of harness wiring. These helpful features are described in accompanying text: full-size layout cemented to "deck" for reference; side panels left off for convenience; temporary harness supports "standoffs" for positioning.

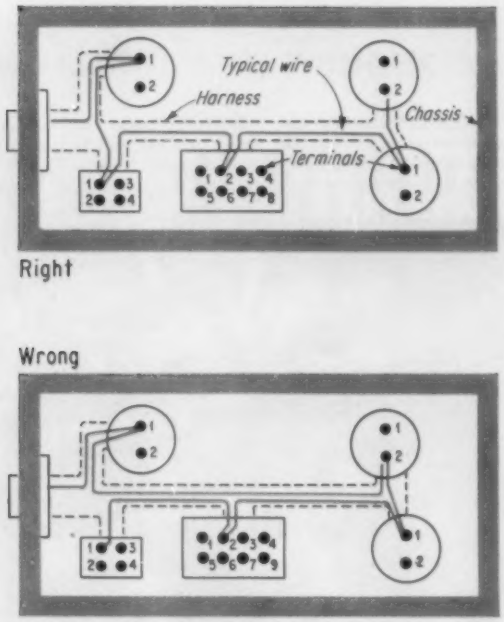




TWO-DIMENSIONAL HARNESS BOARD is cheaper than mockup, but can only handle single-plane assemblies, or relatively flexible bundles that can be made flat and bent to shape later. Grid paper cemented to the plywood board helps position the bundles. Special pins hold the connectors and harness legs; other pins (cotter keys) hold wire ends—wedged in. Notations on the grid help define and locate wiring and components, and a photo of wired board can sometimes serve as assembly drawing. The photo can also help in field repair.



SHIELDED CONDUCTORS must have the shield grounded to the chassis. Only one end of each shield is grounded, otherwise a complete loop—shield-to-chassis-to-shield—would exist, and "loop currents" might be induced. As many as 16 ground wires (22-gage wire is common) can be spliced into one, because currents are negligible.



PREFERRED ROUTING TECHNIQUE is shown in top schematic: it has shortest possible length of wire. Lower schematic has two wires where one would be enough for the long run in main harness.

and even code-names of the components to which the wires are attached. Supplementary information—on drawings and sketches—can help by indicating which wires should be on the outside of bends, and where brackets will be located.

Punched cards can be sorted in any sequence by automatic equipment and the data then tabulated, as shown in the sample list on facing page. Four useful sorting systems are:

"Make from" order. Conductors made from type 1 wire are grouped together, followed by all of type 2, and so forth. For example, type 1 might be 22 gage, insulated, unshielded. Individual wires can then be prepared economically in batches that have the same diameters, materials, and coverings.

• **Circuit points.** All the circuit points in the "from" column (see sample tabulation) are listed alphabetically and numerically. This is useful in troubleshooting and finding where each wire is connected.

• **Code number.** Each wire can be stamped, if desired, with code numbers. This sorting can put them in sequence.

• **"Break-out" point.** The main harness has branches that "break out" at points numbered consecutively from the main harness connection. For convenience in punched-card tabulations, the lowest numbered point at which a wire becomes part of the harness (usually at the connector, but sometimes at one of the other break-out points) is designated the FROM break-out point for that wire. The wire is part of the harness until it reaches its TO break-out point, where it branches off. In the sample each FROM break-out point is designated "1," meaning connector. The TO break-outs are 402 and 401—the "4" means 4th breakout point; the "02" and "01" refer to ultimate destinations of each wire (to relays, etc).

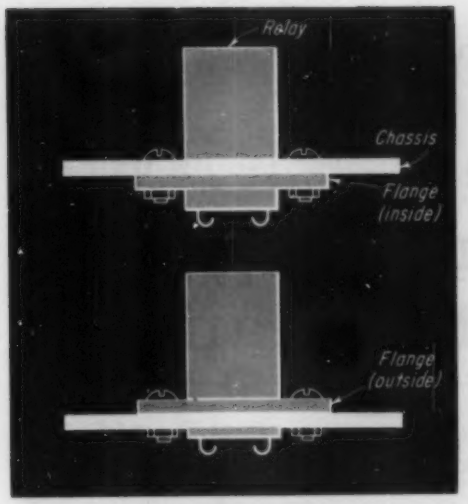
Not all information can be recorded on the punched cards. Wire preparation, stripping, and ferrules are specified on a standard drawing or sheet for each type of wire.

Wires are left longer than necessary, and only one end prepared in advance. This permits cutting to exact length at the time of assembly and assures a uniform harness.

The Old Way—Blueprints

For simpler harnesses that can be made on 2-dimensional assembly boards, the conventional point-to-point listing will work. A table, drawn up and blue-printed by engineering or drafting, will give drawing and specification numbers, wire gage, color, and length of each conductor. Next to conductor information will be data for the "to" and "from" terminals: circuit-point number, stripping length (jacket, shield, wire insulation), tinning specifications, accessories, sleeving, and terminal design.

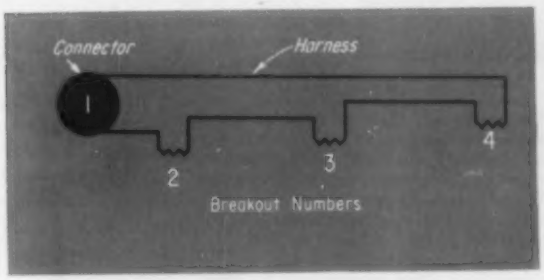
Supplementary drawings and sketches, including routing



COMPONENTS MOUNTED INSIDE the wired product (top picture) allow presoldering of the component to the harness. Outside-mounted components must be attached at final assembly.

Conductor Number	Length, in.	Code	"Make From" Type	Circuit Points		Harness Number	Breakout Number	
				From	To		From	To
A 8	33	1005	5	J 27001-F	K 27030-7	XF-2072	1	402
A 5	40	1002	5	J 27001-G	K 27030-10	XF-2072	1	402
A 6	40	1003	5	J 27001-H	K 27030-13	XF-2072	1	402
A 2	40	999	5	J 27001-J	K 27030-16	XF-2072	1	402
A 3	33	1000	5	J 27001-K	K 27029-7	XF-2072	1	401

FROM SEPARATE PUNCH CARDS information about individual wires is tabulated to become convenient tool for wireman making up harnesses. Advantage: such tabulation includes pertinent information only. Sample here is tabulated in circuit-point order, but could just as well be sequenced by conductor or breakout number.



BREAKOUT NUMBERS in routing sketch for this simple harness start with 1 (for harness connector) and are consecutive for each branch. Even the more complex harnesses pictured on p 83 can follow this pattern—assigning 1 to the connector for each harness.

drawings of individual harnesses, will also be required. If sketches are used in production, it is the responsibility of manufacturing supervision to keep the sketches up to date. Example of a flat harness made by the conventional old method is shown in the photograph on page 83.

ASSEMBLING THE HARNESS

Whether to choose a flat assembly board, or a 3-dimensional mockup that duplicates the product's contours, depends principally on the stiffness of the harness wiring. For small-dia bundles (less than 15 wires) and for straight harnesses of any size, the wiring can be spread out flat on a single board. But for large harnesses that have sharp bends in more than a single plane, the bundles must be formed on a mockup to approximately final shape. Once laced, the bundles are too stiff to manipulate in assembly; and a large bundle, if bent after lacing, will have taut wires on the outside and loose wires on the inside of the bend.

3-D Mockup

A mockup—made from plywood—can simulate the chassis "deck," front panel, and (when required) back panel. Side panels and other parts not useful for making up the harnesses are purposely left off. Usua'ly, the front contains switches and meters, the rear panel has power and signal connections, and the deck holds electronic components and wire harnesses. Whether each device and connector will be flanged (or screwed) from the outside or the inside should be determined at the outset—both for the prototype and for the final design.

A full-size layout drawing is cemented to the chassis deck, and openings are cut to accommodate all components to be wired. Support posts ("standoffs"), with saddles, hold the harnessed wire bundles in final position. Small holes are drilled where test jacks are planned, but since the jacks will assemble from the side opposite the wires, these holes are only used to hold the loose wire ends in position, and out of the way.

Flat Harness Boards

A 2-dimensional board is cheaper than a 3-D mockup and should be used where possible. Most of the previous discussions on more complicated wiring harnesses will still apply. Punched cards are not usually justified, however.

FINAL PRODUCTION

Corrections are made by punching a new card and replacing the obsolete one. Production assembly boards and mockups can be built to match the first plywood models, incorporating later changes and improvements. Photos and supplementary drawings can be filed for permanent reference in the event that field repairs or design revisions are needed. For some harnesses, the photo can even substitute for an assembly drawing.

For REPRINT of above article, just check P45 on one of the Reader Service cards bound in this issue.

(Advertisement)

NO. 5 OF A SERIES

"How to Design Welded Aluminum Structures"

Alcoa Verifies More Liberal Strengths in Design of Welded Aluminum Beams

Mr. Harry N. Hill, *Engineering Design Division Chief, Alcoa Research Laboratories, Aluminum Company of America, reports findings presented at the 1959 annual meeting of the American Society of Civil Engineers.*

The useful strength of a metal beam is seldom determined by reference to its tensile strength. Rather, a beam's load-carrying capacity is judged by its resistance to permanent deformation. Yield strength, therefore, is the common basis for beam design.

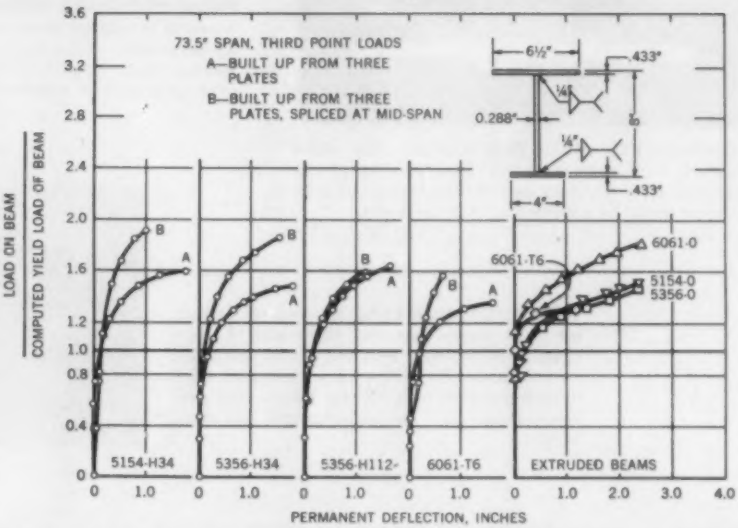
Yield strength values for welded aluminum alloy beams can be computed by applying the concepts of "reduced-strength zone" and "10-in. gage length yield strength" which were discussed in the first two articles of this series. The same procedure outlined in our third article for tension members can be utilized.

Total flange area for this computation is considered as the flange itself, plus one-third the adjacent web area between the flange and the neutral axis. Yield load of the beam is that which will produce a maximum bending stress equal to the yield strength of the tension or compression flange.

The validity of this design technique is demonstrated in the chart at right. Test pieces of aluminum alloy plates were welded to form an I cross section as indicated in the sketch. Both cold-worked and heat-treated alloys are included. "B" specimens were cut at mid-span and butt welded.

Permanent deflection at mid-span was measured with increasing loads. To compare actual yielding with calculated behavior, the applied loads are expressed as a ratio of the computed yield load.

Our tests indicate a high reliability of the computed yield load concept. Note that no significant permanent deflection occurred until the ratio of applied load to computed yield load reached 1.0.



COMPUTED AND ACTUAL YIELDING OF WELDED ALUMINUM ALLOY BEAMS

Further verification of this design rule was gained in tests of extruded beams with the same section as the welded beams. At the extreme right of the chart are similar plots for these beams. Yield loads were computed from tensile yield strengths. Note the similarity in yielding behavior between the welded and extruded beams.

Strength of long slender beams is sometimes limited by sidewise bending and twisting. Here the compression flange buckles much the same as a column. Such failure can be computed by the designer with the "equivalent slenderness ratio" method described in the *Alcoa Structural Handbook*. This technique relates the beam strength directly to design curves for columns. The column curves for welded aluminum alloy beams are constructed as discussed in article No. 4 of this series.

Previous articles in this series have featured reduced-strength zone, 10-in. gage length yield strength, strength of welded members in tension, strength of welded members in compression. Subsequent articles will deal with fillet welds and additional design data.

For top-quality aluminum welding products such as consumable electrodes, welding and brazing rods and fluxes, and solder and soldering fluxes, contact your nearest Alcoa sales office. For more complete information on "Designing Welded Aluminum Structures," write Aluminum Company of America, 1760-D Alcoa Building, Pittsburgh 19, Pa.

For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and "Alcoa Theatre" alternate Mondays, NBC-TV

ALCOA ALUMINUM

WELDING MATERIALS

design guide:

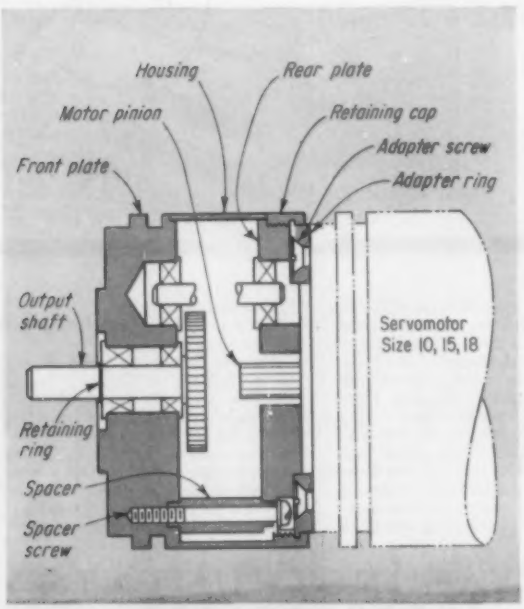
ATTACHING MOTORS TO INSTRUMENT GEARHEADS

Methods include servoclamps, screws, pins, adapter plates and half-rings, plus an eccentric mounting.

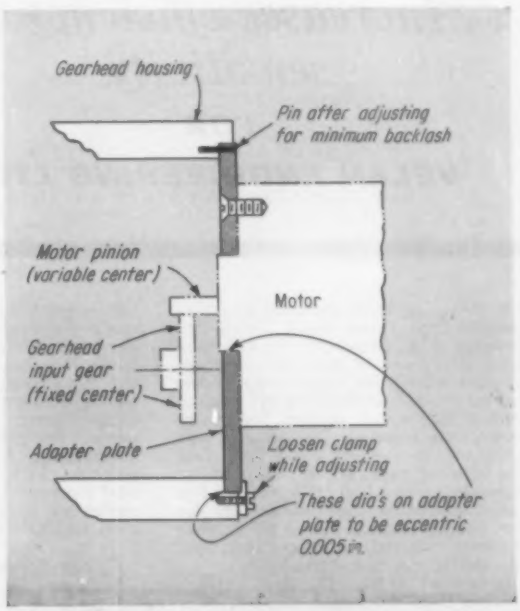
FRANK WILLIAM WOOD JR
Systems Development Dept
Vitro Labs, Silver Spring, Md

Instrument gearheads are increasingly useful in complex servo equipment where space is at a premium. Motors to drive the gearheads are usually mounted in line with them and must be reliably and economically attached. Sketches show some of the various methods possible. The method chosen for a particular design is determined by configuration of the motor, the type of input plate on the gearhead, or a combination of both.

Installation should be simple—it should not require disassembly of gearhead; connection should not loosen under vibration or shock, should not increase diameter of gearhead, should provide adjustment in high-precision requirements, and should provide necessary environmental protection at point of attachment (keep dust, moisture, etc., from entering gearhead). Backlash adjustment is also a desirable feature to include.



1 TYPICAL GEARHEAD and motor using "plate construction" gearhead.

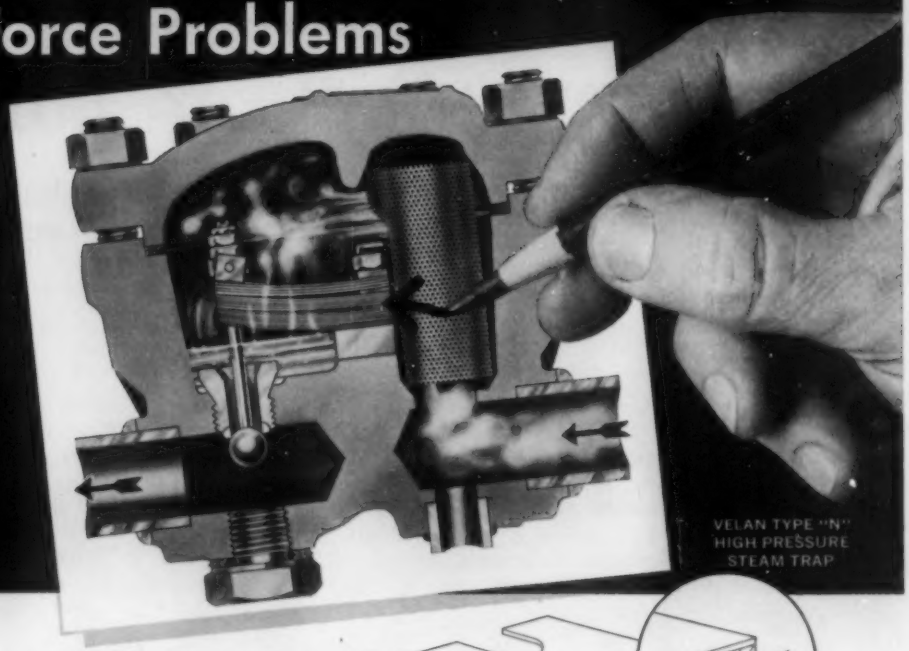

Gearhead housing
Pin after adjusting for minimum backlash
Motor pinion (variable center)
Motor
Gearhead input gear (fixed center)
Adapter plate
Loosen clamp while adjusting
These dia's on adapter plate to be eccentric 0.005 in.

2 MOTOR IS MOUNTED on eccentrically bored adapter plate to permit backlash adjustment. By rotating adapter plate, backlash can be reduced to minimum between motor pinion and gearhead input gear.

continued on page 89

GENERAL PLATE TRUFLEX®

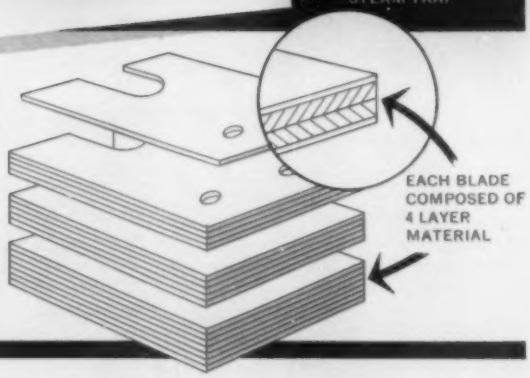
Thermostat Metal Solves Corrosion and Force Problems



. . . *Increases efficiency and sensitivity*

FOR

VELAN ENGINEERING LTD.



In designing their universal and high pressure type steam traps, Velan Engineering Ltd., Montreal, Canada, were faced with a severe corrosion and force problem in designing the actuator blades. To solve this problem with existing Truflex thermostat metals, too many blades were required. The problem was submitted to General Plate Engineers who quickly provided the solution by engineering a new four layer clad Truflex Thermostat Metal that provided the desired characteristics, reduced the number of blades required per steam trap, and increased efficiency and sensitivity.

Here's what Mr. D. E. Tomalty, General Sales Manager, has to say: "Long, efficient, trouble-free steam trap service has become synonymous with the name of VELAN, and most of this success can be attributed to the Truflex Bimetal Element that forms the heart of the product. Two special corrosion-resistant bimetals were developed by General Plate to meet the exacting needs of steam trap service. For general service on low and intermediate pressure/temperature application, TRUFLEX MB 18 has been used successfully for over eight years. A service record of ten years has been compiled with TRUFLEX GB 14 in the High Pressure/Temperature Type 'N' where 2000 psi, 1100°F. operating conditions are common."

To new or regular users of thermostat metal, Metals & Controls has much to offer — over 60 types of TRUFLEX Thermostat Metal (resistivity from 15 to 850 ohms per c.m.f.) — complete technical literature on TRUFLEX — help with parts design — calibrated samples. Our competent field engineers will gladly call at your request. No obligation. Write for complete information.

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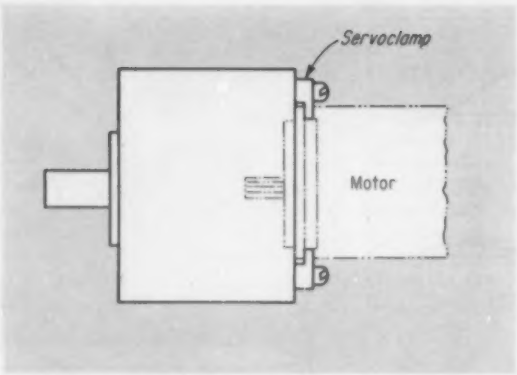
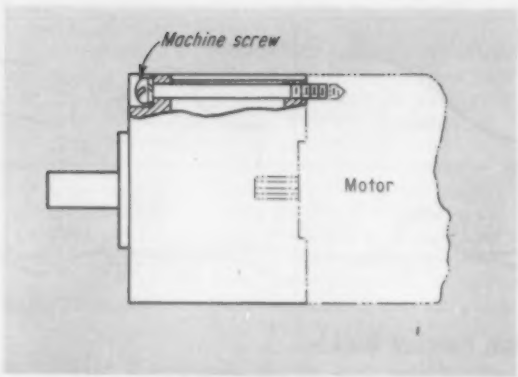
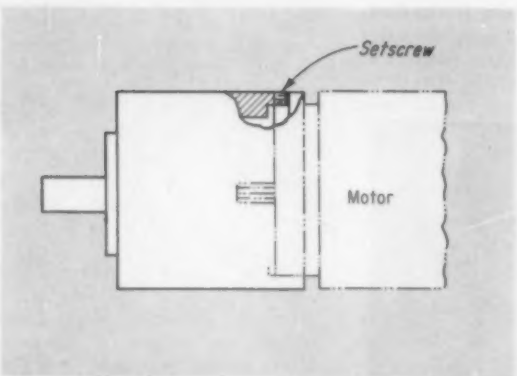
ATTACHING MOTORS continued



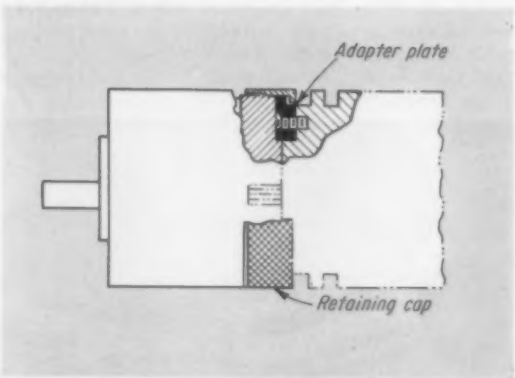
3 STANDARD SERVOCLAMP



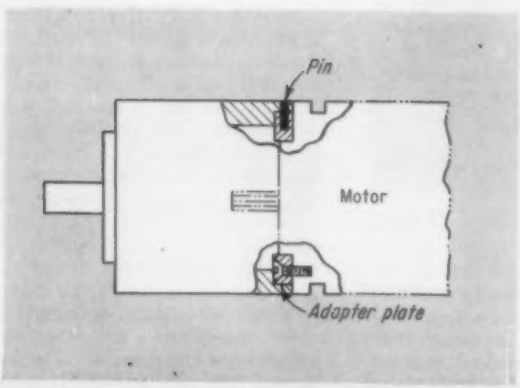
4 BOLT THROUGH GEARHEAD INTO MOTOR



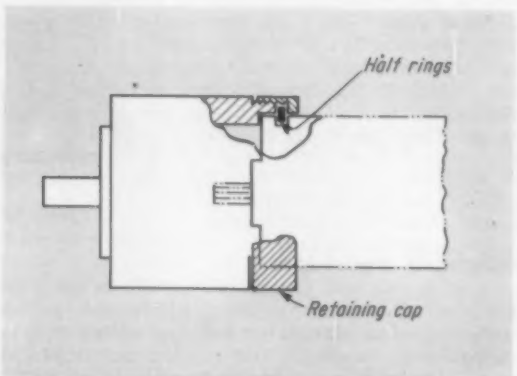
5 SETSCREW THROUGH HOUSING SIDE-CLAMP TO MOTOR



6 ADAPTER PLATE AND RETAINING CAP

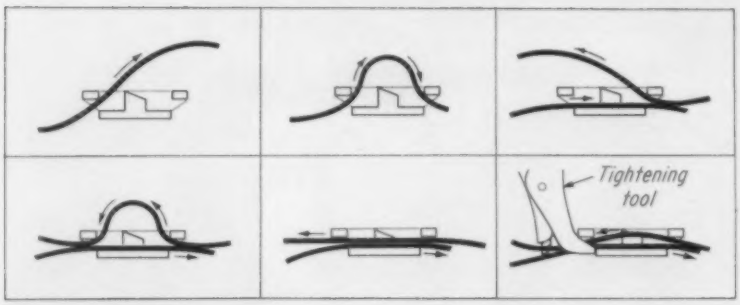


7 PIN THROUGH HOUSING SIDE INTO ADAPTER PLATE



8 TWO HALF-RINGS AND RETAINING CAP

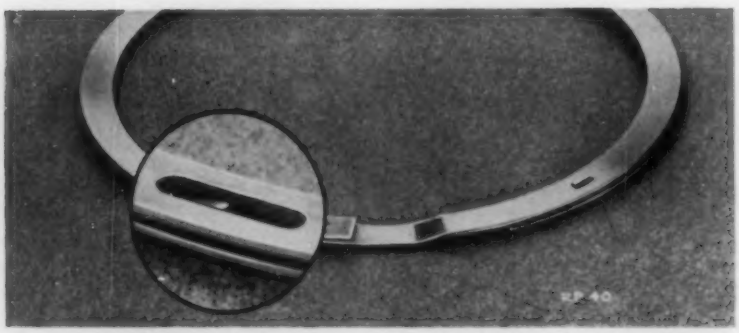
SIGNIFICANT COMPONENTS MATERIALS, PROCESSES



Nylon Ratchet Buckle . . .

holds perforated strapping. One end of perforated strapping holds fast on ratchet button; other end adjusts to desired tightness. Buckle is one-piece, molded nylon, nonconducting and noncorrosive. In three sizes to fit ⅜-, ½- and ¾-in. strapping. Price per 1000 in lots of 1000 to 4999 ranges from $23.10 to $56.43. Tightening tools range from $6 to $7.50. **Weckesser Co, 5701 Northwest Highway, Chicago 46.**

Circle 300 on Reader Service Card



Self-locking retaining ring . . .

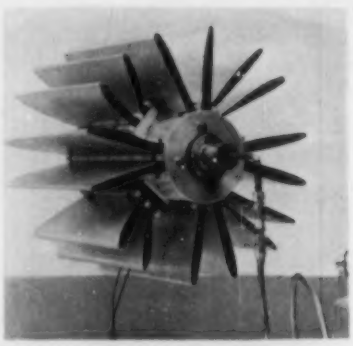
is two-turn, spiral-wound unit incorporating two slots and two punched "tangs" to effect locking action. Ring locks when centrifugal force is applied due to high-speed rotation or when dirt or other foreign material tend to force retaining ring out of its groove. Made from flat spring steel, coiled on edge to make 360° retaining surface. Can be coiled to any diameter within limits of material used. In variety of materials and finishes. Said to be inherently balanced. Offered in sizes from ½ in. up. 3-wk delivery. **Ramsey Corp., Box 513, St. Louis 66.**

Circle 301 on Reader Service Card

Multiheaded transistors . . .

combine any type or types of transistors presently in use. Combination of individual transistors within multiheaded package is said to create no interference and to avoid contact with any other transistor within package. Hermetically sealed and welded units are designed to meet applicable MIL specifications. Priced 25% less than combined prices of individual units. **Electronic Transistors Corp, 9226 Hudson Blvd, North Bergen, NJ.**

Circle 302 on Reader Service Card



Thermoelectric generator . . .

automatically converts heat of burning propane gas directly into electricity. Unit has no moving parts. Produces 5 w of power, steadily and continuously, for about 1 yr on $10 worth of fuel (50 gal.) and will keep running as long as fuel supply lasts. By storing 1000 lb of propane gas with generator, it is said it could run unattended for 5 yr. Cylindrical power plant is 12 in. high and 12 in. dia; weighs 10 lb. Employs thermopiles of semiconductor elements to convert heat of burning propane into electricity. Suitable for use where other sources of electricity are not available or have short life span and must be replaced or recharged. Generator is expected to cost $500 or less in production quantities. Single evaluation samples are available at approximately $5000. **General Instrument Corp, Thermoelectric Div, Newark, NJ.**

Circle 303 on Reader Service Card

Shrinking polyethylene film . . .

is produced by process that employs electron-beam generator to bombard polyethylene with up to 2 million volts. This changes molecular structure of polymer and produces irradiated plastic film said to be more than 6 to 8 times stronger than conventional polyethylene and to be non-aging. Processing increases strength by more than 500% and makes possible stretching the material, in both directions, more than 200%. When exposed to hot air or hot water at 180 F, film shrinks by 20% and will continue to shrink equally in all directions as temperature is increased until it returns to original size. Retains stretchability after shrinking. Shrink-tight fit, through controlled hot-air shrink techniques, is combined with

clarity and gloss. Can be used for packages that ship well without breakage and display well regardless of temperature or humidity conditions, as well as for wire bundling. In test marketing, film has been priced at 3¢ per 1000 sq in. compared with 2.7 to 3.3¢ for regular polyethylene. **Cryovac Div, W R Grace & Co, 3 Hanover Sq, New York 4.**

Circle 304 on Reader Service Card

Governor actuates or controls

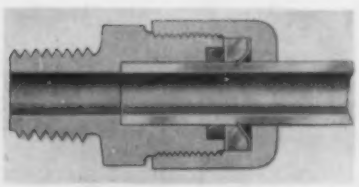
equipment operated by compressed air. Precise tolerances and special ball with controlled travel make governor snap open when setting pressure has been reached rather than allowing air to seep gradually through as pressure climbs. This provides immediate full-open port through which controlling air passes. Unit is adaptable to pressures from 20 to 250 psi through use of adjustable locking screw and set of springs. Cutin and cutout, or differential, pressures range from 4 to 14 psi upwards for special or standard applications. Said to endure 3 million uninterrupted cycles. Price is $12 each. Delivery from stock. **Wilkerson Corp, 1656 W Girard, Englewood, Colo.**

Circle 305 on Reader Service Card

Micromeasure potentiometer

measures extremely short mechanical travel or deflection. Can provide full travel as small as 50/1000 in. with resolution as fine as 1 part in 200 or ½%. Spring-loaded rectilinear potentiometer provides directly useable output without amplifiers. Major use is in special testing, such as measuring distortion or expansion of parts, but it may also be used to measure travel of hydraulic valves. Withstands: temperatures from —65 to 275 F, 500 F for short periods; humidity of 95%; 50 g acceleration on all axes; shock of 100 g for 3 millisec. Service life is said to be in excess of 500,000 cycles. About $150 each. Delivery, about 6 wk. **Humphrey Inc, 2805 Canon St, San Diego 6, Calif.**

Circle 306 on Reader Service Card



OD-type fitting for tubing . . .

connects copper, plastic or aluminum. Connections are said to be made without clamps required with insert-type fitting used with plastic pipe and without flaring, belling or soldering usually required in connecting metal tubing. Tube is inserted in fitting with twisting motion as far as tubing will go. Positive seal is accomplished through use of butyl O-ring seal that is partially embedded within fitting. Connection is reported to be leakproof for vacuum, gases and fluids over wide range of pressures and temperatures. Serrated spring-steel ring, positioned ahead of O-ring seal, bites slightly into outer tube surface. Because the fitting presents no inner obstruction to pipeline, there is no restriction to flow. Can be turned full 360° without lessening effectiveness of seal or reducing grip of fitting. Fittings are made from nontoxic nylon, Cycolac or polypropylene resins. Threads are standard IPS. Available for use with standard tubing from ¼ to ⅜ in., male or female threads. List prices range from 41 to 76¢ each, depending upon size and material. Delivery begins May 1. **D & G Plastics Co, Kent, Ohio.**

Circle 307 on Reader Service Card

Clear sintered glasses . . .

for glass-to-metal sealing applications permit visual inspection of seal and measurement of its stress patterns. Can be produced in variety of shapes and sizes with extremely close tolerances. Materials retain thermal endurance, corrosion resistance and dielectric strength of parent glass. Can be made from glass compositions now used for sealing to Dumet, Kovar, molybdenum, platinum and other metals. **Corning Glass Works, Corning, NY.**

Circle 308 on Reader Service Card

Long-life indicator lamp . . .

is said to have rated life ten times greater than comparable lamps, 3000 to 5000 laboratory test hours. Consists of redesigned short-base indicator lamp, plastic color (red, green, yellow or white) lamp caps, multisocket strips (in 6- and 12-socket lengths) for panel mounting and single sockets. Standard lamps are offered in 4, 6, 10, 12, 16, 24 and 28 v. Standard current ratings are 35 to 45 milliamp. Cost of lamp, colored cap and socket in quantity is said to be about ⅓ the cost of comparable combinations; individual socket to be about 1/20 the price of existing units. **Sylvania Lighting Products, Div of Sylvania Electric Products Inc, 730 3rd Ave, New York 17.**

Circle 309 on Reader Service Card

Angular-position transducer . . .

measures small angular movement and maintains advantage of precision potentiometer. Sensitive to rotation of 0.012° and has range of ±3° to ±5°. Magnified input of small angular movement actuates wiper that moves across precision potentiometer and produces high-level dc output that can normally be used without amplification. Sealed unit is said to meet or exceed most applicable Mil specs for vibration, shock, acceleration and humidity. Transducer is oil-filled to increase life, eliminate noise and damp resonant frequencies. Uses class 5 ballbearings. Flat frequency response to 30 cps has been reported without discontinuities or excessive wear. Weighs 11 oz. Actuating shaft is fastened to flexible bellows coupling, permitting radial shaft misalignment of 0.030 in. External element adjustment is possible with zero-degree index point that can be adjusted ±10% of total range after installation. External locking nut secures index point at any desired setting. Price on request. Delivery, 12 wk. **Bourns Inc, 6135 Magnolia Ave, Riverside, Calif.**

Circle 310 on Reader Service Card

Integrated power steering . . .

systems are for highway and off-the-road motor vehicles with axle loadings of 1500 to 128,000 lb. Full- or part-time power steering is available, controlled by strength of centering spring ordered for control valve. Manual steering is possible through mechanical steering gear in case of engine failure. System, which makes all components available from the same manufacturer, is attached to steering linkage on vehicle undercarriage. Basis of design is single servovalve and one of four high-pressure, double-walled cylinders capable of operating up to 2000 psi, depending upon application. Cylinders have stroke lengths of 8-12 in. in 1½ in. dia; 9-16 in. in 2 in. dia; 12-17 in. in 2½ and 3½ in. dia. Reported to cost less than custom-built components. **Vickers Inc, Detroit 32.**

Circle 311 on Reader Service Card

Compressed-air filter . . .

made of absorbent cellular material, removes oil and oil vapors from compressed-air and gas lines without swelling or

continued on page 92

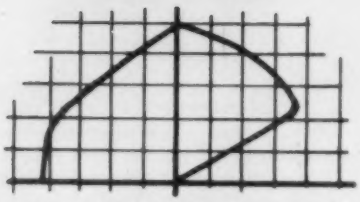
Newest Addition to

STEWARD'S MAGNET FAMILY

High Energy Product

F-500

ORIENTED CERAMIC PERMANENT MAGNET



BH=3.5 x 10^6 G.Oe

Hc=2000 Oe Br=3900 G

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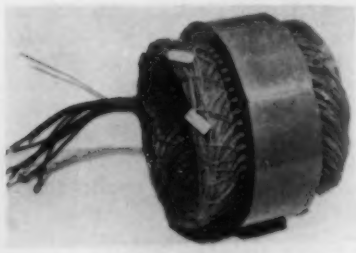
increasing in particle size. Particle size reduced to less than 10 microns on all types of solids. Filter element is said to hold 87% of its weight in water and 79% of its weight in oil. Currently available with cleaning capacities of 500,000 to 4,000,000 cu ft of compressed air. Prices range from $15.50 to $198 for basic unit. Elements are priced from $2.50 to $8.50 each. **Beach Precision Parts Co, 120 Mechanic St, Boonton, NJ.**

Circle 312 on Reader Service Card



Built-in overload protection . . .

is available on three-phase induction motors up to 125 hp, frame sizes 254 U to 445 U, in any insulation class or enclosure. Protection is provided by two or more miniature heat-sensing switches buried in stator windings. Sealed probes, about 2½ in. long, extend into windings from sugar-cube-size snap-action switches. Connected in series with starter contactor coil, they need no amplification to shut motor off whenever internal winding temperature exceeds predefermined amount. **General Electric Co, Schenectady 5.**

Circle 313 on Reader Service Card

Miniature precision brake . . .

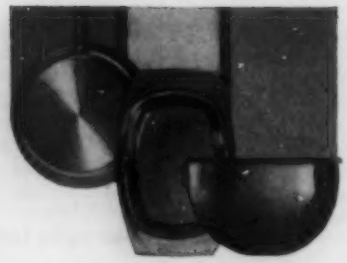
engages when energized. Has torque output of 35 in.-oz at 24 v dc with zero backlash. Power consumption at 28 v dc is 2 w with temperature range from —85 to 257 F. Meets applicable portions of MIL-E-5272. Measures 1 in. OD and 0.780 in. long and is ballbearing equipped. Can be supplied with terminals or leads. **Orbit Instrument Corp, 131 Eileen Way, Syosset, NY.**

Circle 314 on Reader Service Card

Teflon-glass laminate . . .

is said to combine chemical and electrical properties of Teflon and physical and mechanical properties of glass cloth. High-temperature laminate is made from Teflon resin and fine-weave, 0.002 glass fabric. Made in standard 17 x 37-in. sheets in thicknesses from 0.006 to 0.250 in. Normally manufactured to MIL specification

continued on page 96



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Your J&L stainless steel distributor can serve you better *because J&L serves him better*, backing him with the full facilities of J&L's Stainless and Strip Division.

Your J&L distributor can reduce your costs by providing a complete range of pre-production services, and doing it economically! He can save you the capital investment required to maintain long term inventories; he can help you eliminate the costs of overhead connected with stocking, accounting, and the inevitable losses incurred through waste and obsolescence due to specification changes.

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J&L — a leading producer of stainless steel and precision cold rolled strip steels

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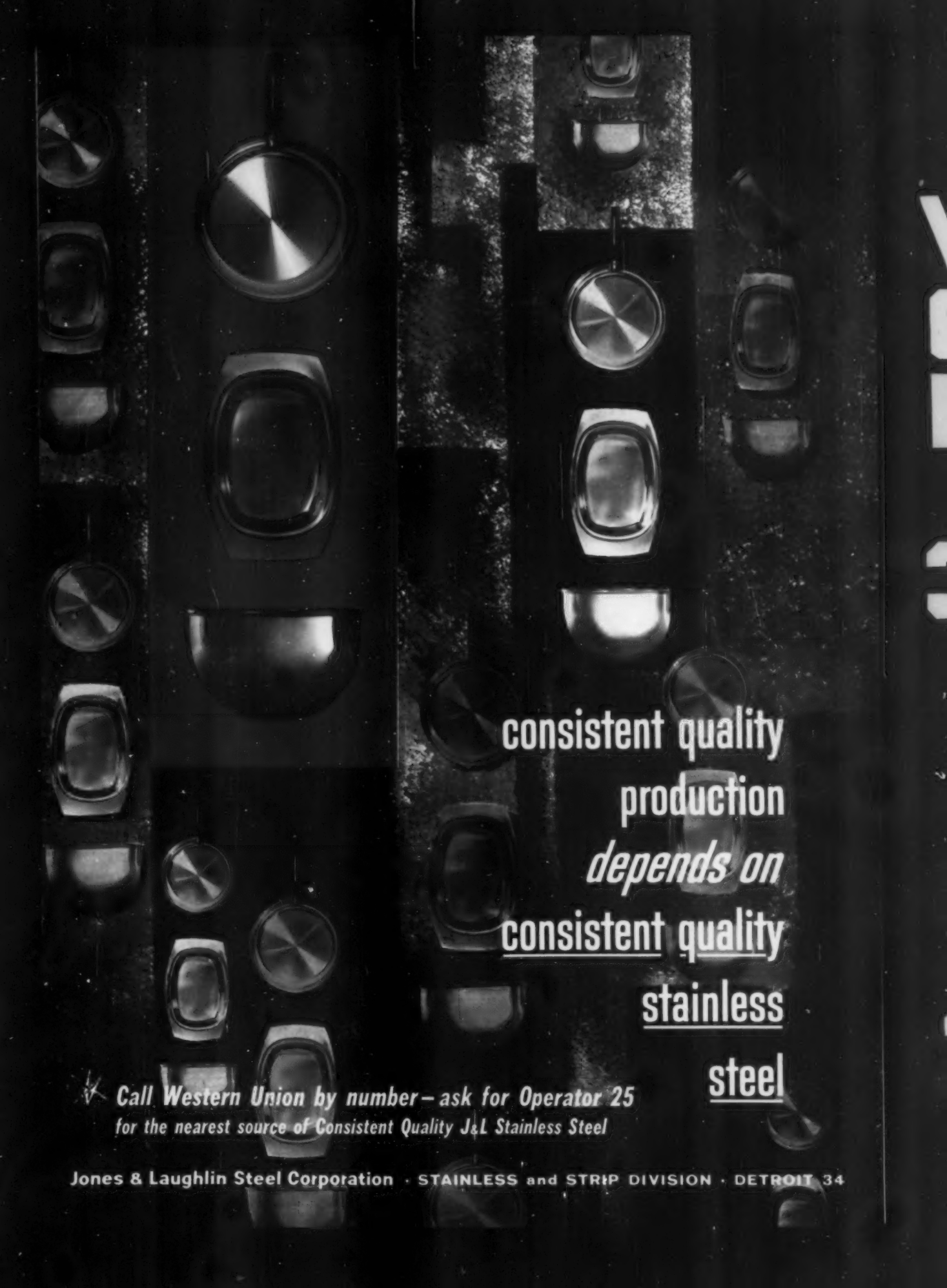
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Redmond specializes in just one thing—the design, development, and manufacturing of fractional horsepower electric motors—we make no products to compete with you. Redmond motors are tailor-made to fit each specific application exactly, and therefore give you the most economical, efficient, high-quality, long-life motors available.

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New 12-page catalog describes and illustrates basic line of Redmond fractional horsepower electric motors, blowers, and special products. Send request for your free copy to Redmond Company, Inc., Owosso, Michigan

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HIGH TEMPERATURES?
COMPOUNDS EFFECTIVE TO +550° F

TECHNICAL MEMO ON LINEAR COMPOUNDS
8251-70—8250-85—8252-90

. . . outstanding for O-Rings, V-Rings and U-Cups.
• truly effective sealing at temperatures to +550°F
• suitable for use with a wide variety of fluids, including oils, fuels, water and diverse chemicals
• good resistance to compression set and wear

FLUIDS COMPATIBLE WITH THESE COMPOUNDS

Acetone • Acetylene Tetrabromide • Air • Amyl Alcohol • Aniline • Arochlor 1248 • Benzine • Carbon Disulfide • Carbon Tetrachloride • Chloroform • Cyclohexane • Dowtherm A • Styrene • Sulfuric Acid • Toluene • Benzol • Dry Chlorine Gas • Ethyl Alcohol • Ethylene Dichloride • Ethylene Glycol • Gasoline • GE 81406 • Hexane • Isobutyl Alcohol • JP-4 and JP-5 Fuels • Kerosene • Methylene Dichloride • Trichloroethylene • Turpentine • Water • MIL-F-25558A Fuel • MIL-L-7808 Lubricants • MIL-O-5606 Hyd. Fluid • MLO-8200 Hyd. Fluid • MLO-8515 Hyd. Fluid • Naphtha • Nitrogen • OS 45-1 Hyd. Fluid • Petroleum Base Oils • Silicone Fluids • Steam • Wet Chlorine Gas

For complete technical data—including list of incompatible fluids, request Bulletin 56700-1. Linear Inc., State Road and Levick St., Philadelphia 35, Pa.

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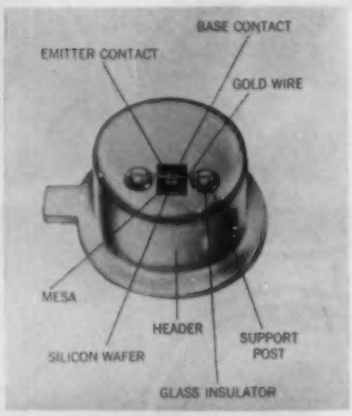
LINEAR
LINEAR INC. STATE ROAD & LEVICK ST. PHILA 35 PA

thickness tolerances. One or both sides of laminate may be bonded with 1- or 2-oz copper foil. Clad laminate is suitable for high-temperature (392 F) printed circuits and also microwave applications. Prices of laminate range from $25.65 for 0.006 in. sheet to $241.62 for ¼ in. sheet. Sheets are made to order, but can be produced quickly. **Mica Insulator, Div of Minnesota Mining & Mfg Co, Schenectady 1.**

Circle 315 on Reader Service Card



High-performance transistors

to meet military and industrial requirements are achieved in production quantities by using advanced diffusion techniques and assembling transistor in controlled environment. Technique is being used to produce, initially, two NPN transistors for switching applications in computer circuitry and for high-frequency amplification. Prices for the diffused-silicon mesa transistors are said to be competitive. Available for immediate delivery. **National Semiconductor Corp, Danbury, Conn.**

Circle 316 on Reader Service Card

Multiunit reset timer . . .

provides automatic control of eight sequential operations, such as in molding machines. Timer calibrated from 0 to 60 sec. Timing ranges to 10 min. can be supplied. Also available are timers for dual-timing, single operations and other multiples. **Zenith Electric Co, Dept PE-1, 152 W Walton St, Chicago 10.**

Circle 317 on Reader Service Card

Encapsulated servomotor . . .

is integrally cast in thermosetting epoxy resin. Motor, size 11, uses O-ring mounting to seal motor and gear train from coolant fluids or gases in uses where unit is completely immersed. Said to meet hu-

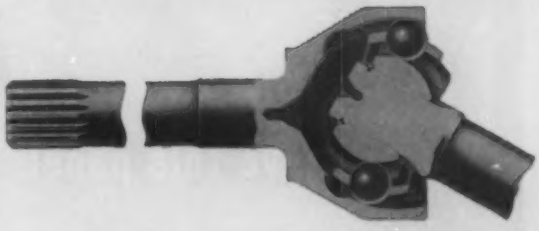
continued on page 98

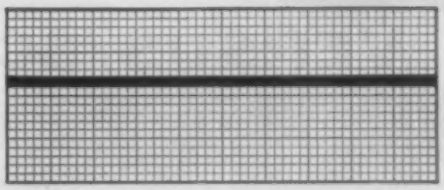
RZEPPA Universal Joints Transmit Torque Smoothly—*Even At High Angles!*

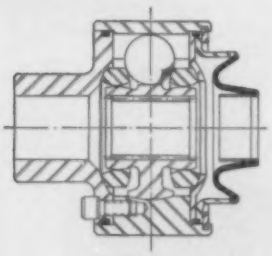
Rzeppa universal joints transmit 100% precision-smooth torque continuously—at angles of 35° and higher! Constant velocity action completely eliminates chatter, roughness and vibration. Size for size, you get longer shaft and bearing life, higher torque capacity with Rzeppa joints than with any other type!

The secret of Rzeppa's uniform power flow is that the driving balls are always in the bisecting plane of the driving and driven shafts. No matter what the shaft angle, torque flows evenly at constant velocity.

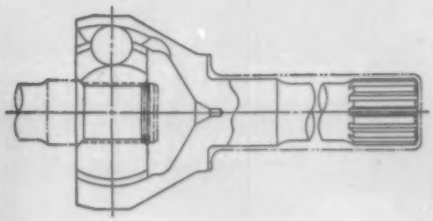
Rzeppa constant velocity joints are available in a wide variety of sizes, styles, angles and speeds. Rzeppa joints have been used successfully in equipment ranging from giant road-building and mining equipment to the most intricate aircraft and missile applications.



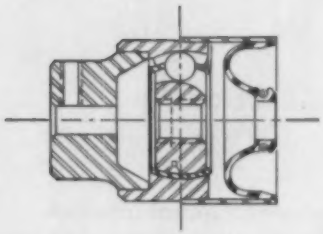




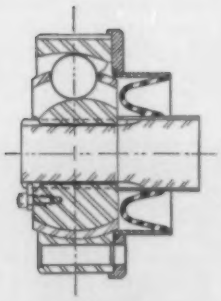
"MX" Type CV Joint (⅜" to 3½" swing diameter) . . . designed primarily for high speeds, low angles . . . blowers • compressors • servo motors • pumps • control devices • frequency converters • missiles • aircraft • dynamotors



Bell-Type CV Joint (15/16" to 2½" axle shaft diameters) . . . designed for high-angle driving steering axles used in road building machinery • mining machinery • industrial • automotive applications



"OV" Type CV Joint (2⅛" maximum swing diameter) . . . designed for smaller applications . . . ordnance • machine tools • seryo mechanism • farm equipment • automotive equipment



Disc-Type CV Joint (from 2⅛" to 16¼" swing diameter) . . . designed for all types of industrial drive applications where constant velocity and trouble-free service are required.

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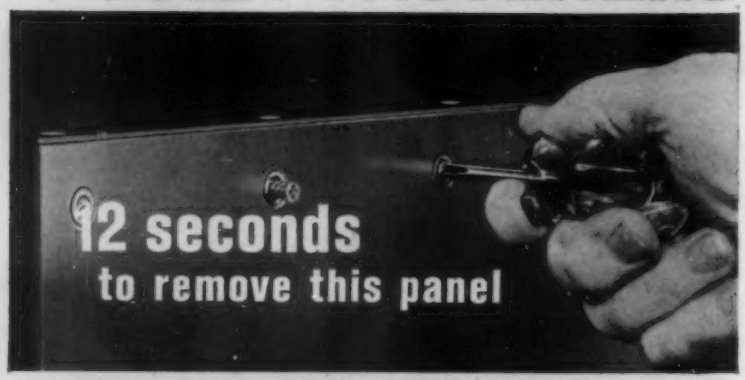
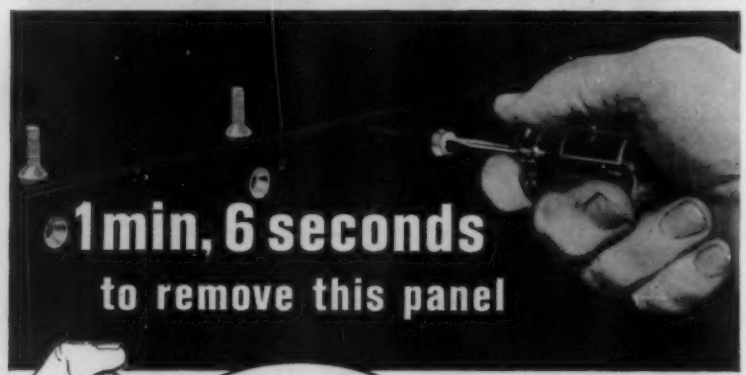
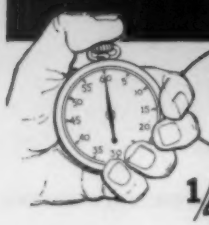


VERSUS SCREWS





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The odds are in your favor by 5½-to-1 when you design-in Camloc ¼-turn fasteners. By actual test, you save that much time—compared to screws—in removal and replacement of these panels. What's more, there are no loose parts – Camloc fasteners are "captive" in the mating panels. By all odds, Camloc ¼-turn fasteners cost you less to use, save you time, save you effort in fabrication and service. Millions of fasteners in use today are proof of their outstanding, money-saving qualities. Write today for Catalog.

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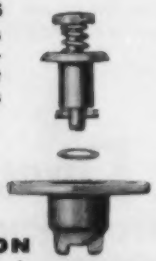

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midity, salt-spray, temperature and vibration requirements of MIL-E-5272B. Stall torque is 0.62 in.-oz; no-load speed is 6200 rpm. Torque at max power output of 0.9 w is 0.33 in.-oz. Speed at max power output is 3200 rpm. Unit weighs 3.5 oz. For continuous duty at stall torque. Operates in —67 to 159.8 F. Cedar Engineering Div, Control Data Corp, 5806 W 36th St, Minneapolis 16.

Circle 318 on Reader Service Card

Fluorosilicone sponge rubber has dense, uniform, nonabsorbing, closed-cell structure. Has little change in physical properties in temperatures of —100 to 500 F. Suitable for soft gasketing and vibration dampening. Delivery from stock in 12 x 12-in. and 24 x 24-in. molded sheets, ⅛-, 7/16- and ¼-in. thicknesses. The ¼-in. material is $14 per sq ft. Connecticut Hard Rubber Co, 407 East St, New Haven, Conn.

Circle 319 on Reader Service Card

Electromechanical interlock . . . mechanically retains extremely high loads and simultaneously provides electrical interlock and positioning information. Originally designed for multiple switching and signaling applications in aircraft, missile and missile launching systems, unit meets MIL-S-7029, MIL-E-5272 and MIL-S-4040. Five independent internal SPDT switches are directly connected to retaining pin and can be set to ±0.010 in. of predetermined operating point. Two or three switches can be made to operate at beginning of stroke while remaining switches operate at end of stroke. Electroid Corp, 95 Progress St, Union, NJ.

Circle 320 on Reader Service Card

Controlling multimeter . . . is said to guard virtually any critical voltage, current or resistance. Combines multimeter, with customary ranges, and con-

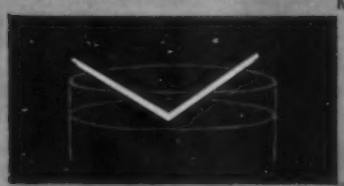
continued on page 101

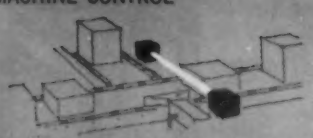
Announcing
Infrabeam
...the revolutionary photoelectric control using modulated infrared radiation

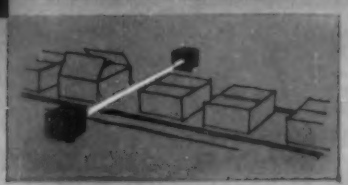
Model 9101

LONG-RANGE DETECTION

MACHINE CONTROL


LIQUID LEVEL CONTROL


INSPECTION OR SORTING


CONVEYOR CONTROL

FOR THE FIRST TIME, photoelectric control is *simple, reliable,* and *practical* over an extremely wide range of applications.

Infrabeam is a totally new type of photoelectric control . . . developed and tested over a period of more than a year, now ready to go to work in your plant or as part of equipment you manufacture. It offers a combination of simplicity, sensitiveness and reliability that has never before been achieved.

New infrared detectors, perfected for missile guidance, are in many ways superior to photocells that respond to visible or ultraviolet light. In Infrabeam, the Receiver contains a similar infrared detector which is screened against visible light by a simple optical filter. Further, the infrared beam from the Projector is "modulated" — brightening and dimming at a frequency of 400 cycles per second. The Receiver is electronically tuned to this frequency, so that the control will not respond unless it gets a signal from the associated Projector.

WHAT THIS MEANS TO YOU...

Compared with standard "general purpose" photoelectric controls, Infrabeam provides far greater sensitiveness in countless applications at close or moderate range. At extreme range — as much as 1000 feet — it offers superior reliability and freedom from interference. Because it operates equally well by reflecting the infrared beam from a detected object and into the Receiver, it is the *only* photoelectric control able to reach into "blind" areas with perfect freedom of installation.

Projector and Receiver are attractively housed in anodized cast aluminum. The quick-detach hinge allows easy separation for use as opposed units, or accurate angling for use in reflection. Physical mounting and electrical connections are simplicity itself, and permit quick replacement of either unit without disturbing permanent wiring.

Find out how simple and practical photoelectric control can be for *you.* WRITE TODAY FOR COMPLETE DETAILS AND SPECIFICATIONS.

ELECTRONICS DIVISION

CRAMER CONTROLS

CORPORATION

CENTERBROOK, CONNECTICUT

IF A *MINIATURE* OR *INSTRUMENT* BEARING IS NEEDED . . .

NEW HAMPSHIRE

. . . IS THE *SOURCE!*

To meet the exacting requirements of your applications, New Hampshire maintains a full line of miniature and instrument bearings for research and development, prototypes and replacements at all regional offices. (Production quantities are shipped direct from our main plant.) NHBB sales engineers are always on call to discuss your particular needs and make specific recommendations.

RETAINER BEARINGS

This is one of the most frequently specified types for instrument applications. Available with newly designed crown retainers. This design permits even ball spacing, low torque, and most consistent performance. *Over 150 standard types and sizes are listed in our Design Manual.*

SIZES

(Available in a wide selection of combinations within the following ranges)

	BORE	O.D.	WIDTH
Min.	.0469	.1562	.0625
Max.	.3125	.6250	.1960

EXTENDED INNER RINGS . . . available on all above types

FULL BEARINGS

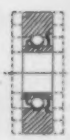
Full bearing (Available plain or flanged)

Specified for applications requiring maximum radial load capacity. Not suited to low torque requirements. *Over 21 standard types and sizes.*

SIZES ➡

	BORE	O.D.	WIDTH
Min.	.0250	.1000	.0312
Max.	.3125	.5000	.1562

UP and WAFER BEARINGS



A wafer bearing compared with standard equivalent

Expressly designed for use in synchros, servos, small motors, potentiometers, and gear trains. Widths are significantly narrower than standard to allow more room for rotors and stators. *Available in 16 types and sizes.*

SIZES:	BORE	O.D.	WIDTH
Min.	.0550	.1875	.047
Max.	.1875	.4375	.1094

QUALITY PERFORMANCE . . .

is in direct relation to quality of production. *All New Hampshire bearings* are made to ABEC-7 tolerances or better. The result is *improved running qualities* for all users . . . at no extra cost! In addition, rigid quality control during manufacture and continuing research enables New Hampshire to maintain leadership in our field . . . to supply you with the finest bearings for your needs at the lowest cost.

IMMEDIATE DELIVERIES FROM STOCK . . .

(For research & development, prototypes, and replacements) are made from our three regional offices as well as the main plant. Bearing specialists are on hand to help you plan and specify. Call your nearest office collect for fast service.

NEW HAMPSHIRE BALL BEARINGS, INC.

51 Cutter Mill Road
GREAT NECK, NEW YORK
HUnter 2-8633 TWX: 1421U

566 Northwest Highway
DES PLAINES, ILLINOIS
VAnderbilt 7-6646 TWX: 1642U

1540 North Highland Avenue
HOLLYWOOD 28, CALIFORNIA
HOllywood 4-0208 TWX: LA 933U

(main plant)
PETERBOROUGH, NEW HAMPSHIRE
WAlnut 4-3311 TWX: 209U

NEW DESIGN MANUAL

Newly revised and expanded, this authoritative publication is a guide to designing around, specifying and purchasing of miniature and instrument ball bearings. Comprehensive general information, catalog data, and engineering bulletins are included in the 100-plus pages. A personally registered copy is available to qualified engineers, draftsmen, and purchasing departments.

For your free Design and Purchasing Manual, write or call any New Hampshire Office.

NEW HAMPSHIRE BALL BEARINGS, INC.

PETERBOROUGH, N. H.

tinuous reading meter-relay with adjustable set points. Measures 11 x 6 x 6 in. Regardless of value being monitored, continuous-reading meter relay permits control action to be linked directly to signal. SPDT load relay has 5-amp contacts. Controlling multimeter covers following ranges: 2.5, 10, 50, 250 and 1000-5000 v dc; 2.5, 10, 50, 250 and 1000-5000 v ac; 0-100 microamp; 0-10 and 0-100 milliamp; 0-10 amp; resistance to 20 megohm in three scales wth center scale values of 12, 1200 and 120,000 ohm. **Assembly Products Inc, Chesterland, Ohio.**

Circle 321 on Reader Service Card

Low-cost pressure regulators

are identical externally, but differ internally. Model 6 is constructed of UL-approved materials for LP gas; Model 7 of UL-approved materials for acetylene gas. Die-cast zinc units have internal parts of brass, and diaphragm and disk of oil-resistant Buna-N. Both are available in ¼-in. size only. May be used as two-, three- or four-way regulators. **Watts Regulator Co, Industrial Div, Embankment Rd, Lawrence, Mass.**

Circle 322 on Reader Service Card

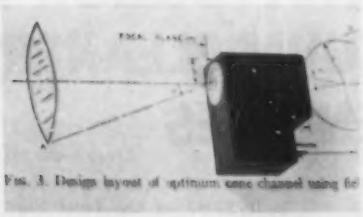


FIG. 3. Design layout of optimum cone channel using fo

Cone-channel detector cell . . .

is said to improve f/number of associated optical system to near optimum f/0.5 value when incorporated in light or heat detection and measuring systems. Reported to be insensitive to light originating outside field of view. Cone produces equal sensitivity over aperture area. Entrance aperture is 5 mm dia and uses silica glass lens coupled to reflective cone tapering to 1 mm dia at small end, where lead sulfide cell is placed. Metallic cone is encapsulated in epoxy block, and unit is sealed. **Williamson Development Co Inc, 317 Main St, West Concord, Mass.**

Circle 323 on Reader Service Card

Photovoltaic detector-capsule

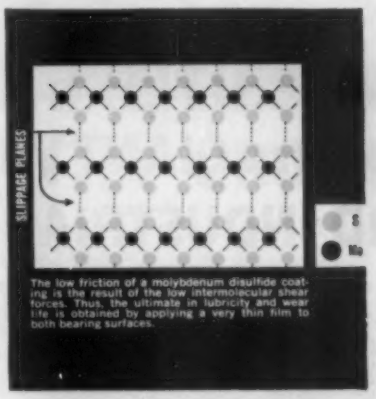
line has been expanded to include three new types, with current outputs of 300, 250 and 200 microamp at 1250 ft-c of tungsten illumination. Subminiature capsules, 0.5 in. long and 0.08 in. dia, have

continued on page 105

MoS_2+

FORMULA FOR
TOMORROW'S LUBRICANT

One-time lubrication . . . permanent, *dry* lubrication . . . applied with the greatest of ease to virtually any type of material—that's just a small part of the amazing story of what Poxylube can do for you.



The low friction of a molybdenum disulfide coating is the result of the low intermolecular shear forces. Thus, the ultimate in lubricity and wear life is obtained by applying a very thin film to both bearing surfaces.

Poxylube replaces conventional greases and oils, does away forever with the need for lubrication, and can be bonded permanently to structural metals, metal products, wood, plastics and glass. Poxylube can be applied by spraying, dipping or brushing, with no surface pre-treatment except degreasing.

Poxylube performs! It supports pressures up to 90,000 psi, operates in temperatures between −100° F. and +500° F., and has a coefficient of friction range of from .08 to 0.1. It's effective in thicknesses between .0001 and .0004 inch.

How does Poxylube do it? The molybdenum disulfide pigment making up most of the Poxylube film consists of a multitude of flat laminar platelets—40 molecular layers to a millionth of an inch—of alternating molybdenum and sulfur atoms. These layers permit approximately 39 slippage planes to a millionth of an inch . . . thus achieving high film strength and adhesion.

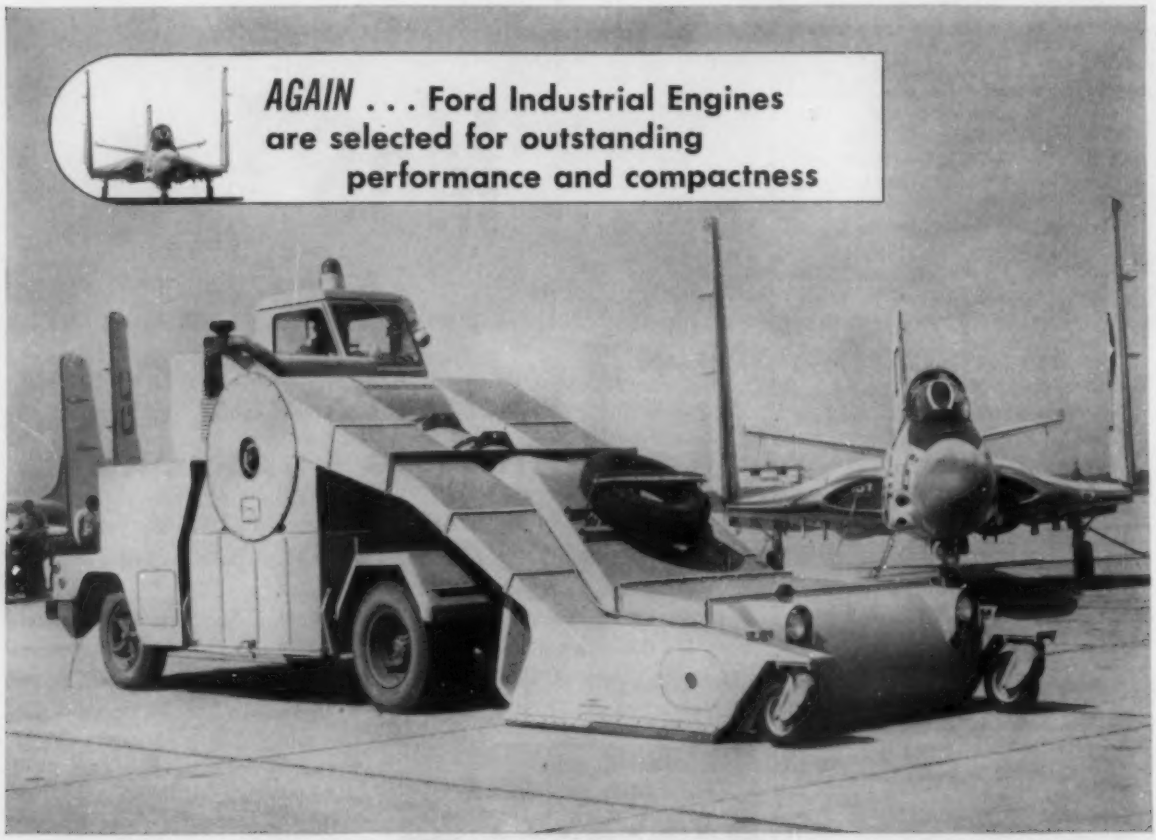
Whether you're lubricating eggbeaters or engines, hinges or helicopters, Poxylube can help you do the job better, permanently, and at less overall cost. Poxylube is currently being used in major missile and space projects. Write for information today.

Pioneering in Industrial Dry Lubricants

POXY LUBE

POLY CHEM • 541 South Webster Avenue, Indianapolis 19, Indiana

CIRCLE 101 ON READER SERVICE CARD



Leading OEM powers GIANT VACUUM CLEANER with FORD INDUSTRIAL ENGINES

PROBLEM: How to keep airports free of dirt and debris that cause tremendous damage when "sucked up" by powerful jet engines.

SOLUTION: Use Consolidated Diesel Electric's Model 2095 Vacuum Sweeper shown above!

Powered by two modern Ford Industrial Engines, the Consolidated Sweeper is designed to clean one million feet of runway per hour . . . picking up such debris as sand, gravel, wire, nuts and bolts. Just as Ford power contributes to the effectiveness of this unit, it can bring a new kind of efficiency to your equipment. Here's why:

Ford's full line of Short Stroke engines are compact, durable and economical to operate. Ford's space-saving construction and *high power-to-weight ratio* also give you a distinct manufacturing advantage: greater freedom of design.

Ford engines range from 134 to 534 cubic inches—including two highly efficient diesels. All are available as complete engine assemblies or power units. And, remember, because Ford engines can be serviced by any local Ford Dealer, your customers can get quick on-the-job service when they need it.

These are but a few of the important reasons why equipment designers, sales managers and top management are specifying Ford Industrial Engines. It will pay you to swing to Ford power if you haven't done so already.

FORD POWER IS RIGHT FOR YOUR EQUIPMENT, TOO!

Ford
INDUSTRIAL ENGINES
AND POWER UNITS

INDUSTRIAL ENGINE DEPARTMENT, FORD DIVISION, FORD MOTOR CO., P.O. BOX 598, DEARBORN, MICH.

West of Rockies write to:
FORD INDUSTRIAL ENGINE DEPT., P.O. BOX 6787, LOS ANGELES 22, CALIF.
FORD INDUSTRIAL ENGINE DEPT., P.O. BOX 1666, RICHMOND, CALIF.

ENJAY DELIVERS 1,000,000th LONG TON OF BUTYL!

PRODUCTION FACILITIES INCREASED TO MEET CONSTANTLY GROWING DEMAND

There have been many elastomers developed since the first commercial ton of Butyl was used in 1943, but no other rubber, synthetic or natural, offers so many outstanding properties for so many applications.

Plant expansion plans announced recently will increase butyl production capacity some 50 percent by 1961 and, at today's rate of consumption, the two million-ton mark will be reached within the next six or seven years. Two new additions to the butyl product line, Chlorobutyl and Butyl Latex, will soon be available in commercial quantities.

VERSATILE ENJAY BUTYL'S OUTSTANDING PROPERTIES MAKE IT SUPERIOR TO OTHER RUBBERS FOR MANY APPLICATIONS. SOME ADVANTAGES:

- **RESISTS TEAR AND ABRASION** ... used in the new and revolutionary all-butyl tire.
- **STANDS UP AT HIGH TEMPERATURE** ... used in steam hose and tire curing bladders
- **HAS EXCELLENT ELECTRICAL PROPERTIES** ... used in high voltage cable insulation
- **IS IMPERMEABLE TO GASES** ... used in virtually all rubber air-holding applications
- **HAS WIDE RANGE OF DYNAMIC PROPERTIES** ... used in over 100 applications on the modern automobile
- **DISPLAYS OUTSTANDING CHEMICAL RESISTANCE** ... used for the storage and shipment of many chemical and commodity products
- **WITHSTANDS EXPOSURE TO SUN AND WEATHER** ... used in irrigation pipe and roof coatings.

Want to find out fast, how versatile Butyl can improve your product? Call or write the nearest Enjay office.

ENJAY® BUTYL

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY COMPANY, INC.

15 West 51st Street, New York 19, N.Y.

Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa • Toronto

CIRCLE 103 ON READER SERVICE CARD 103

how to pick

the one right SOLID PIN for the job

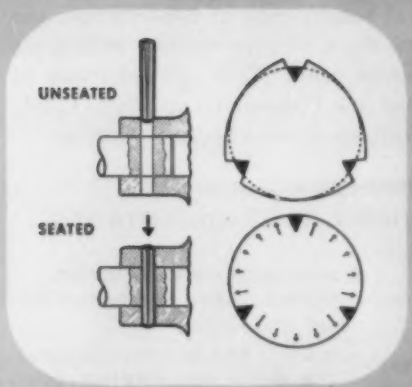
(the solid Groov-Pin is still the safest, surest way to pin two parts together)

The Groov-Pin has the holding power of a press fit pin *without* the need for close tolerances, and the ease of installation of a taper pin *without* the need for reaming.

You just drill the hole and drive the pin home. Once seated it stays there . . . no matter what the condition of shock or vibration.

Available in low carbon steel or other materials (stainless pins are Type 303, nonmagnetic). Diameters from 1/32" to 1/2" are standard; specials are available and priced as standard in lots above 5000.

Write today for a copy of our comprehensive 28 page catalog. Groov-Pin Corporation, 1141 Hendricks Causeway, Ridgefield, N. J.



the unique GROOV-PIN locking principle

When a Groov-Pin is driven, the material displaced by the grooves is forced to flow back, setting up a powerful locking force. The ability of Groov-Pin to hold under severe shock and vibration . . . and its immunity to vibration fatigue . . . has been thoroughly proved by the billions in use!

GROOV-PIN

fastening gears, pulleys, sprockets, collars and cams to shafts.

type 1

The basic Groov-Pin and most widely used. Has three full length grooves tapering from maximum diameter at one end to nominal diameter at the other.

locating pins, stop pins, hinge pins.

type 2

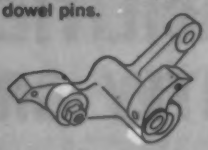
Grooves cover only one half of pin length. Used where holding power is not critical. Speeds assembly because ungrooved portion acts as a pilot.

clutch and brake pedals to cross shaft; bike pedal arms to brake shafts.

type 3

Recommended for severe shock and vibration applications, its full length parallel grooves give it great holding power. Type 3H is essentially the same, but has pilots on both ends suiting it for hopper feeds.

stop pins, locating pins, dowel pins.



type 4

Similar to Type Two, but taper on grooves is reversed, meaning groove end is inserted first. This is particularly good on blind hole applications.

aircraft cowling, cover plates for buses, trucks.

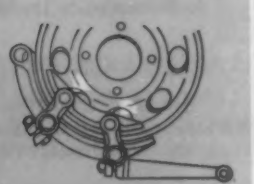
type 5

Has three oval grooves half the length of the pin, centrally located. Especially suited for quick removal and replacement. Type Five is also well suited for hinge pin applications.

spring anchors, spring control pins.

type 6

Same as Type Two, but with annular grooves on ungrooved end for spring anchor or retaining ring. Type Six is for through holes; Type Seven for blind holes. In addition, annular grooves may be machined to your specification — for use with retainer rings, for example. See catalog for standards.



type 7

Use postpaid card. Circle No. 226

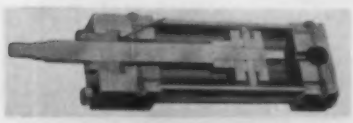
dark-reverse currents of 5 microamp max, 10 microamp and 20 microamp. Original unit in line has current output of 300 microamp and dark-reverse current of 10 microamp max. Solar-cell, light-sensitive units are hermetically sealed in glass capsule. Operating-temperature range is —85 to 302 F. Response time is less than 10 microsec. **Hoffman Electronics Corp, 1001 Arden Dr, El Monte, Calif.**

Circle 324 on Reader Service Card

5-in-1 reversing transmission

offers two speeds forward, neutral, reverse and speed reduction. Unit, which measures 10 x 10 x 12⅝ in. long, transmits up to 8 hp at max recommended input speed of 2400 rpm. Reduction ratio is 1.97:1 and 3.36:1 in forward speeds and 3.49:1 in reverse. Can be shifted smoothly as often as necessary and under full load. **Snow-Nabstedt Gear Corp, 251 Welton St, Hamden, Conn.**

Circle 325 on Reader Service Card



Piston-rod flange seal . . .

is now standard on Miller air cylinders. Combines dynamic-rod flange seal with static-rod bushing sealing ring into single unit, which seals by pressure. Pressure-balancing ring installed at base of seal protects it against blow-out action of trapped pressure. **Miller Fluid Power Div, Flick-Reedy Corp, York and Thorndale Rds, Bensenville, Ill.**

Circle 326 on Reader Service Card

Teflon solenoid valves . . .

are said to be shock resistant, pressure-proof and to outlast and outperform steel in most corrosive medium now used in American industry. For normally closed applications in all normal ac and dc voltages. Available for immediate delivery. **Valcor Engineering Corp, 365 Carnegie Ave, Kenilworth, NJ.**

Circle 327 on Reader Service Card

High-strength, low-alloy steel

has corrosion resistance said to be equivalent to copper-bearing mild steel. Fabrication in as-rolled condition is limited to simple bending across rolling direction and very light flanging and forming operations. Fusion welding can be done by any common method without pre- or post-heating. Material meets SAE specification 950 and ASTM A-242-55. Can be

continued on page 106

Another H&S Speed Reducer

on a tough job . . .

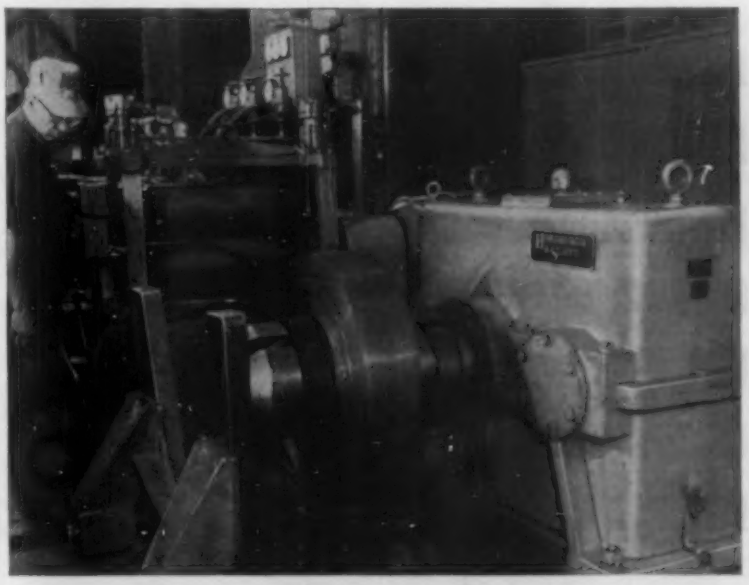
Built rugged for a critical rewind operation, this heavy overhung-load type H & S Herringbone Speed Reducer delivers day-in-day-out service under exacting load conditions.

This standard unit was selected for use on a Bliss precision rewind coiling machine—where strip steel must undergo tension controlled recoiling for subsequent annealing treatment.

Notice the sturdy shaft, with heavy-duty bearings designed to take this heavy overhung load. Observe the rugged housing, made to last.

This built-in toughness typifies H & S construction—on helical, herringbone, worm and combination units.

Send for detailed information on our facilities for producing a complete line of gears and speed reducers in a wide range of sizes and ratings.



Heavily loaded pay-off reel being driven by H & S Speed Reducer in plant of The Acme Steel Company, Chicago.

H&S The HORSBURGH & SCOTT CO.

5112 Hamilton Avenue • Cleveland 14, Ohio

Specializing in fast production of quality Speed Reducers and Gearing to meet custom requirements.

FUTURA!®
CHART-PAK'S NEW DRAFTING FILM

Saves Time — Saves Money

Now Chart-Pak brings you "Tomorrow's Drafting Film Today" . . . an amazing new drafting medium on "Cronar."*

REDUCED SMUDGING
HEAT RESISTANT
RESISTS CRACKING
HIGH TEAR STRENGTH
SUPERIOR TRANSPARENCY
MOISTURE PROOF
ERASES EASILY
VERY FLEXIBLE
WON'T YELLOW WITH AGE
NO STRETCH OR SHRINK
LIES FLAT
DOESN'T "DOG-EAR"
COSTS NO MORE THAN HIGH-GRADE CLOTH OR VELLUM

Write Today for Full Information and Free Sample

CHART-PAK, INC.
ORIGINATOR OF THE TAPE METHOD OF DRAFTING
174 River Road, Leeds, Mass.

*DuPont Registered Trade Mark

supplied in both hot-rolled strip and hot-rolled sheet. Thicknesses range from 0.074 to 0.0971 in. inclusive in 50-in. max width; from 0.0972 to 0.1270 in. in 60-in. max width; from 0.1271 to 0.375 in. in 72-in. max width. For uses requiring high strength, but only moderate corrosion resistance. **Armco Steel Corp, Middletown, Ohio.**

Circle 328 on Reader Service Card

Single-acting cylinder . . .

has 1-in. bore and ¾-in. stroke. For air service to 150 psi or oil or water service to 500 psi. The ½-in. ram is drilled and threaded with ⅞ in.-18 internal thread to allow insertion of hardened face pad or 15° swivel pad. Swivel or face pad has ½ in. adjustable length. **Superior Controls, PO Box 436, Commercial Rd, Crystal Lake, Ill.**

Circle 329 on Reader Service Card

Hydraulic power check unit . . .

provides cushioning action to thrust of air- or hydraulically operated cylinder by offering a controlled counter-force that opposes action of cylinder. Operates on dashpot principle in which hydraulic fluid is forced through one-way valve by force exerted by operating cylinder. Rate of flow (adjustable) through valve governs amount of cushioning action. May be operated with any type of air, oil or water-operated cylinder. Various standard models provide strokes up to 20 in. and operating pressures to 3000 psi. **Appco Div, Pokorny Industrial Products Co, 10643 Memphis Ave, Cleveland 9.**

Circle 330 on Reader Service Card

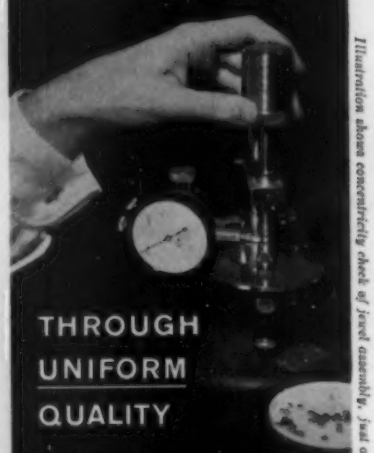
Differential transformers . . .

operate nominally from 6.3 v, 60 cps, and have sensitivity of 10 v per in. at rated excitation. Used for measurement or sensing of linear motion, range is ±0.15 in. with linearity stated at 0.25% or better. Said to measure changes of linear motion of as little as 0.0001 in. Units, with stainless steel enclosure, are 2 in. long and have ⅞ in. OD. Standard units operate over temperatures of —60 to 220 F. Standard production models are

continued on page 110

Bird
JEWEL BEARINGS

CUT YOUR COSTS



THROUGH UNIFORM QUALITY

Exacting quality control standards employed by Bird are your guarantee that every Bird Sapphire or Glass Jewel Bearing, or Complete Jewel Assembly or Cushion Jewel Assembly, is as specified. There's never a chance of inconsistency in dimensions, chemical and physical properties.

As an added benefit, Bird Complete Assemblies cut your manufacturing costs because they reach you ready for immediate installation . . . eliminating all problems with expensive rejects and breakage.

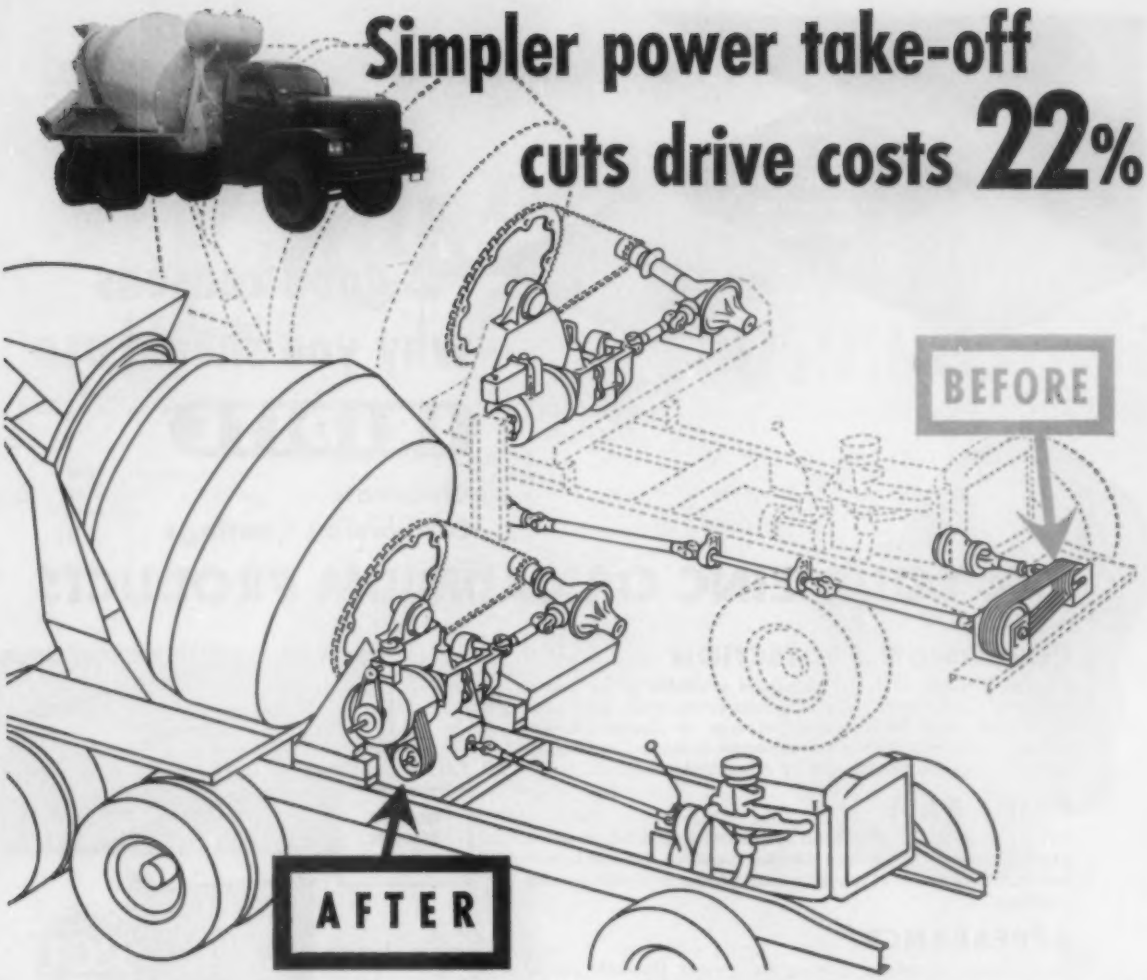
Our engineering staff would be pleased to work with you on your special jewel bearing needs. Write for our free catalog with complete details on properties and uses of jewel bearings.

Richard J. Bird & CO. INC
1 SPRUCE ST., WALTHAM, MASS.

serving industry with fine jewels since 1914

Illustration shows concentricity check of jewel assembly, just one of several important quality control steps.

Simpler power take-off cuts drive costs 22%



Super HC V-Belts—packing higher hp capacity in smaller space than conventional V-belts—have eliminated need for front-end power take-off on concrete-mixer trucks made by Concrete Transport Mixer Company of St. Louis, Mo.

By letting take-off be shifted to rear, Super HC V-Belts cut drive costs alone by 22%, besides saving weight and cost of complex linkage and other components of the former front-end drive.

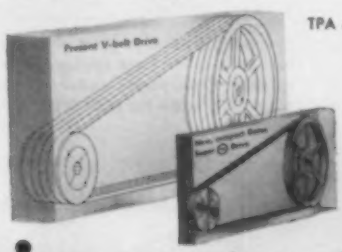
With Super HC, sheave diameters can be cut 30% to 50%, drive space up to 50%, and drive weight 20% and more. A product of Specialized Research in the world's largest V-belt laboratories, Super HC V-Belts are helping many manufacturers put more compact, lighter weight, lower cost drives on all types of machines.

Engineering Service Nation-Wide

What's *your* power transmission design problem? Your Gates Field Representative is ready to help you solve it—to cut space, weight, cost with Super HC V-Belt Drives. Ask him for your free copy of *"The Modern Way to Design Multiple V-Belt Drives"* or write The Gates Rubber Company Sales Division, Inc., Denver, Colorado.

TPA 485

The Gates Rubber Company, Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ontario



Gates *World's Largest Maker of V-Belts*

Gates Super HC V-Belt Drives

same hp capacity in smaller "package"

CIRCLE 107 ON READER SERVICE CARD 107

LOOK FOR THE DIAMONDS—SIGN OF FINISHING QUALITY

4 good reasons why you should use IRIDITE®

Chromate Conversion Coatings

ON YOUR ZINC OR CADMIUM PRODUCTS

CORROSION PROTECTION

The wide range of Iridite coatings available gives you a choice of corrosion protection—from economical, mild protection of parts for shipment, storage or display, to extremely high protection under exposure to marine and highly humid atmospheres, gasoline or other hydrocarbons.

PAINT BASE

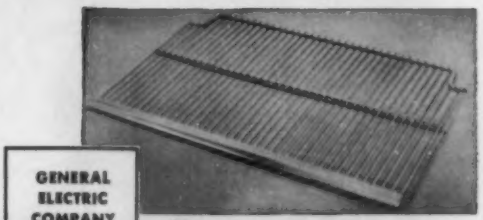
For an extremely tight bond for either baked or air-dried paints, non-porous Iridite blocks moisture penetration—prevents formation of metallic soap products beneath paint coatings.

APPEARANCE

Your choice of colors ranging from clear through yellow iridescent to olive drab. Bright Iridite finishes can also be dyed to provide other color effects.

SPECIAL EFFECTS

Iridite, in combination with other Allied Research processes, can provide a wide variety of finishes. As an example, Iridite 8-P applied to zinc or cadmium, followed by an application of Irilac, gives a highly attractive simulated brass finish.



Medalist
NATIONAL LOCK COMPANY

IRIDITE—a specialized line of chromate conversion coatings for nonferrous metals. Easily applied at room temperatures with short immersion times, manually or with automatic equipment. Forms a thin film which becomes an integral part of the metal. Cannot chip, flake or peel. Special equipment, exhaust systems or highly trained personnel not required.

For complete information on Iridite, contact your Allied Field Engineer. He's listed in the yellow pages under "Plating Supplies." Or, write for FREE TECHNICAL DATA FILES.

Allied Research Products, Inc.

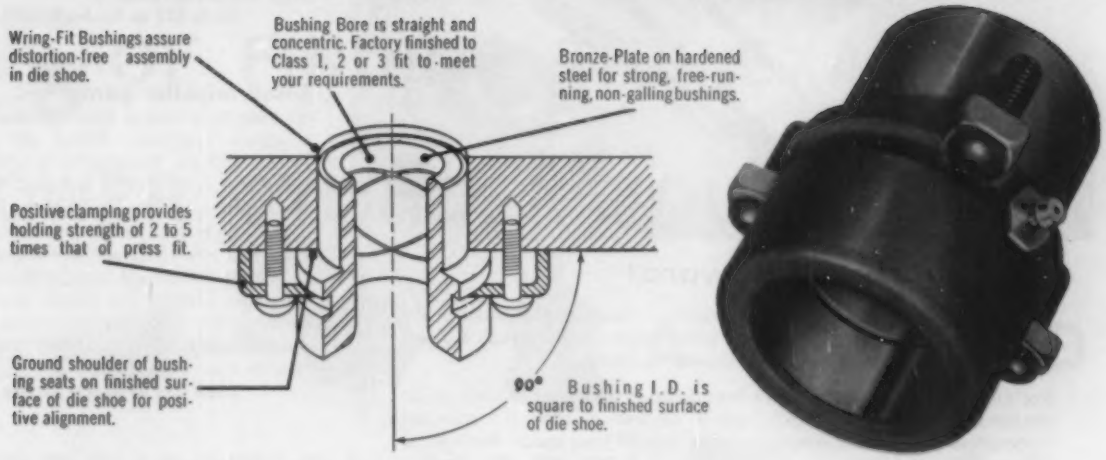
4004-06 EAST MONUMENT STREET • BALTIMORE 5, MARYLAND
BRANCH PLANT: 400 MIDLAND AVENUE • DETROIT 3, MICHIGAN
West Coast Licensee for Process Chemicals: L. H. Butcher Co.

Chemical and Electrochemical Processes, Anodes, Rectifiers Equipment, and Supplies for Metal Finishing

IRIDITE® Chromates | IRILAC® Coatings | ISOBRITE® Brighteners | ARP® Supplies | WAGNER Equipment

Lower Cost . . . Cut Maintenance . . . Lengthen Die Life

Lamina BRONZE-PLATED GUIDE PIN BUSHINGS


Wring-Fit Bushings assure distortion-free assembly in die shoe.
Bushing Bore is straight and concentric. Factory finished to Class 1, 2 or 3 fit to meet your requirements.
Bronze-Plate on hardened steel for strong, free-running, non-galling bushings.
Positive clamping provides holding strength of 2 to 5 times that of press fit.
Ground shoulder of bushing seats on finished surface of die shoe for positive alignment.
90° Bushing I.D. is square to finished surface of die shoe.

LAMINA bronze-plated, wring-fit guide pin bushings are honed on the I.D. for accurate geometry, precise dimensions and to provide the best surface finish for lubrication. Bushings are wring-fit in die shoe to assure distortion-free, full-bearing surface that results in better die alignment, less maintenance and longer die life. In addition the Lamina method of clamping bushings to die shoes provides holding strength of two to five times that of press-fit bushings. For more accurate press operation, higher production and lower maintenance costs —standardize on Lamina, the originators of Bronze-Plated Guide Pin Bushings.

Lamina also manufactures: Steel Bushings and Guide Pins, Bronze-Plated Wear Plates, and Bronze-plated Parts. Complete facilities for the manufacture of steel or carbide precision dies (lamination, progressive, transfer, etc.).

Lamina Bushings and Guide Pins are made in types and sizes to meet every requirement. More than 800 items are described and illustrated in our catalog—write for your free copy.

Lamina®
DIES AND TOOLS, INC.
P. O. BOX 31, ROYAL OAK, MICHIGAN

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Electrical designers . . . product designers . . . heating specialists . . . the list is almost endless. Men who know temperature control specify Robertshaw . . the name that MEANS—*temperature control.*

For most every heating unit from heat pump to annealing furnace to lab equipment to tobacco curing . . . gas or electric . . . there is a standard Robertshaw temperature control to more than fill your needs. And special designs are no problem.

Temperature ranges: 0 to 800°, wide spread, 50° spread or fixed setting for flat line control—factory set and locked

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Types: capillary or bulb, up to 140" capillary for remote location

Action: snap or slow make and break, direct or reverse

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Construction: diaphragm—stainless steel;
case—rugged plated non-rust steel

Have a problem? Need design service? Call Robertshaw . . . the name that MEANS temperature control.

VMA 6992

Call or fill in the coupon for information on any temperature control application. Robertshaw Thermostat Division, Robertshaw-Fulton Controls Company, Youngwood, Pennsylvania.

Robertshaw

Gentlemen:
Please send temperature control information for these applications:

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Company_____
Address_____
City_____ Zone____ State_____

Mail to: **Robertshaw Thermostat Division**
Robertshaw-Fulton Controls Co., Youngwood, Pa.

$25 to $95 each in small quantities. **Magnetic Instruments Co Inc, 546 Commerce St, Thornwood, NY.**

Circle 331 on Reader Service Card

Rerated dripproof motors . . .

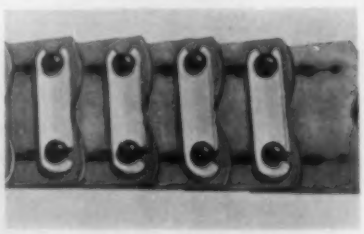
are available in ratings from 1 to 150 hp; frame sizes 182 through 505. General-purpose motors have cast-iron frames with integrally cast feet. Operate continuously at rated temperature rise of 40 C. Available for three- or two-phase, in all standard frequencies and commercial voltages below 600. **Lima Electric Motor Co Inc, Dept 145, Lima, Ohio.**

Circle 332 on Reader Service Card

Small impeller pump . . .

for heavy-duty work in areas requiring subminiature equipment delivers up to 8 gpm at 150 psi. Designed to handle salt water and certain other corrosive fluids. Normal temperature limits are −60 to 350 F. Duty limit is 10 min. Sealed at shaft with rotary face seal that withstands to 600 psi. Centrifugal impeller pump has aluminum housing and bronze impeller. Power source is dc electrical pump. **Hydrodyne Corp, 7350 Coldwater Canyon Ave, N Hollywood, Calif.**

Circle 333 on Reader Service Card



Adjustable belting . . .

in top widths from ⅜ to 4 in. are for use in variable-speed applications. Interchange with molded endless variable-speed belts and wood block belts. Strength member and increased plies per link provide max crosswise rigidity and higher resistance to compression. **Brammer Corp, 486 Broadway, New York 13.**

Circle 334 on Reader Service Card

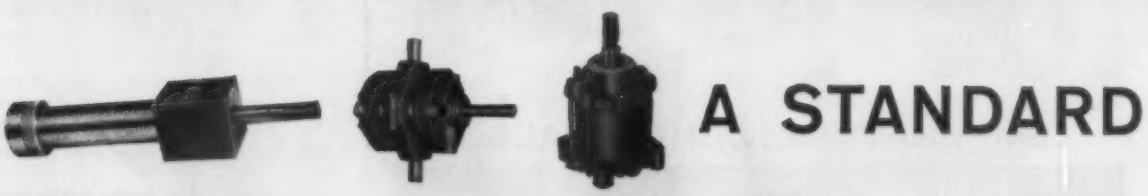
High-performance thermistors

are available with resistances of 1 to 100 k at 77 F. Operate at ambient temperatures up to 572 F. Units are also available for use to 1112 F. Price for 10 to 50 units, $1.75 to $1.95 each. Also offered are disk thermistors with resistances of 0.1 to 100 k at 77 F. These have max operating temperature of 302 F. Price for 20 to

continued on page 112

YOU HAVE A BETTER CHANCE

OF FINDING THE EXACT POWER CYLINDER YOU NEED IN



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Anker-Holth makes the world's widest selection of standard power cylinders. That means that you have a better chance of finding the exact cylinder when you call on us for your power needs. Anker-Holth standard cylinders, built to JIC specifications with bores of 1 to 30 inches and strokes to 40 feet, are time-tested and experience-proved in every major industry. Nine complete lines are offered and all mountings are available.

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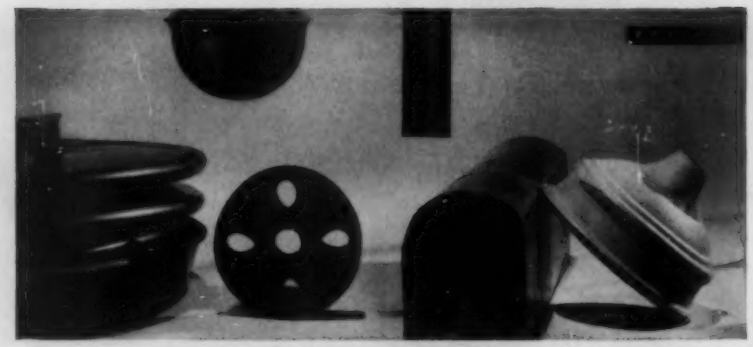
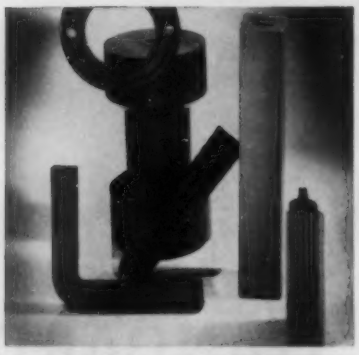
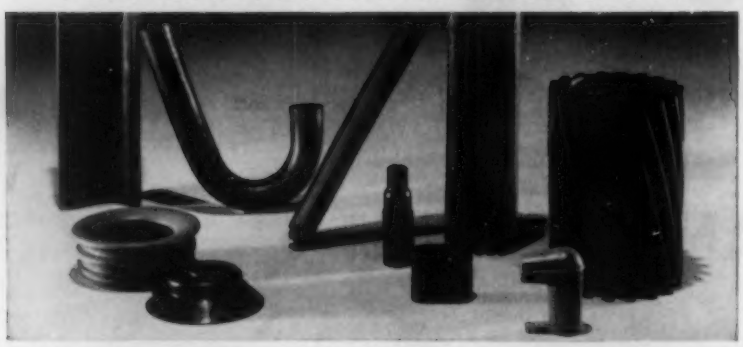
FOR CUSTOM RUBBER PARTS



TO RESIST WEATHER...



TEMPERATURE...CHEMICALS...



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Shown above are custom rubber parts that exemplify Stalwart's total production capabilities and design versatility. Produced to meet customer specifications, complex configurations are molded, extruded, cut, calendered and spliced from special compounds to provide the ultimate in part quality, performance reliability and production economy. And you get a big bonus in *service* with every order ...from the time you request a quotation ... through the design and compounding stages ... right down to *prompt* delivery. Stalwart produces rubber parts from all types of natural and synthetic rubber, including new Viton. Check with Stalwart's Plastic Division for injection molded parts to meet those very requirements.

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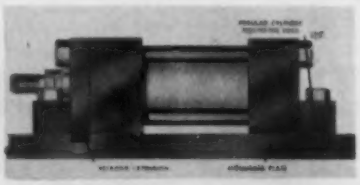
STALWART RUBBER COMPANY

Send for your copy of the new Stalwart Catalog.

The Stalwart Rubber Company
Northfield Road • Bedford, Ohio
Plants in Jasper, Ga., Warren and Bedford, Ohio

50 units, 50¢ each. Standard resistance tolerance for both types is ±20%. Delivery, about 1 wk. Sample kit of 12 assorted thermistors, $15. **Walter Kidde & Co Inc, Main St, Belleville, NJ.**

Circle 335 on Reader Service Card



Power-cylinder mounting . . . is said to eliminate bolting, pinning and/or welding of keys. Mounting is created by providing side-mounted cylinders with flange plate ground to accurate thickness and extending beyond mounting-side surface of cylinder. Cylinder mounts by slipping extended portion of flange plate into slot milled into machine's mounting surface, then is secured by standard mounting provided with cylinder. Available in side lug, flush side and end lug mounting styles in all bore sizes of this manufacturer's air and hydraulic cylinders. **Miller Fluid Power Div, Flick-Reedy Corp, York and Thorndale Rds, Bensenville, Ill.**

Circle 336 on Reader Service Card

Miniature magnetic counter . . . with single-stroke reset is available as additive, four-digit type. Records pulses with no loss of count up to 1800 counts per min. Actuated electromagnetically, counters can be supplied for 6, 12, 24 and 110 v dc. Measures 1⅞ x 1¼ x 2 in.; weighs 3½ oz. **Abrams Instrument Corp, 606 E Shiawassee St, Lansing, Mich.**

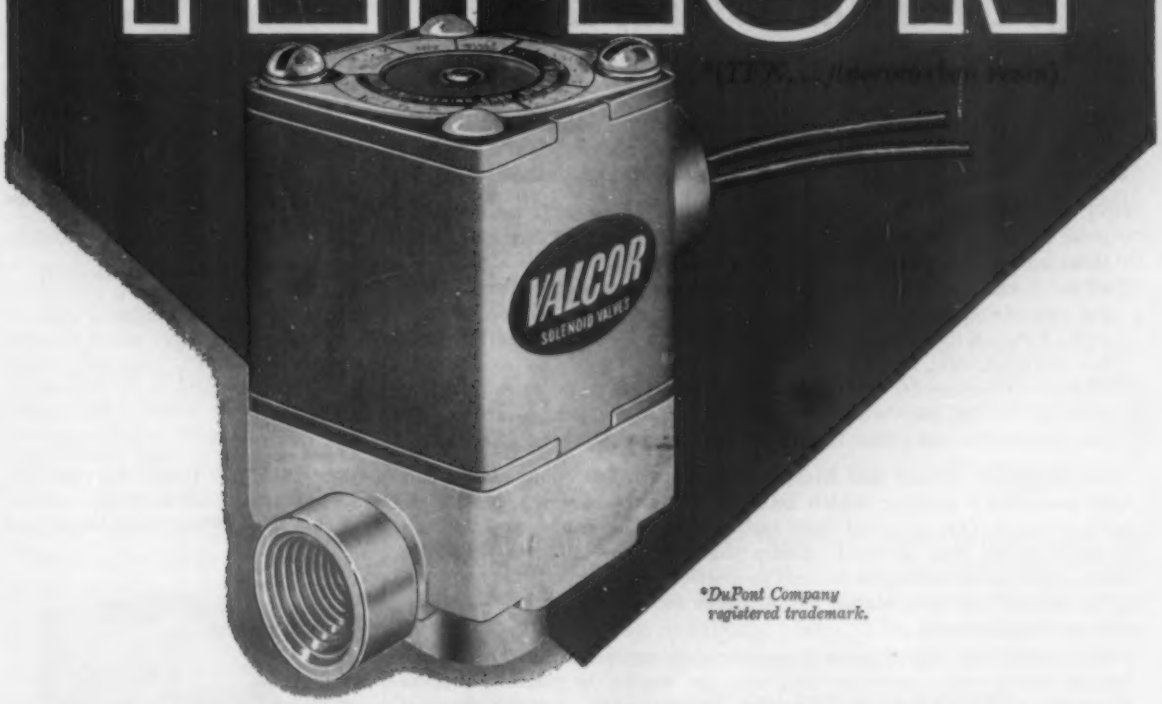
Circle 337 on Reader Service Card

Subminiature electronic timer handles 25 amp, 32 v inductive over ambient temperature range of —67 to 257 F. Designed, primarily, for applications where multiple pulsing can be used to trigger number of programed functions, timers are basically high-current capacity, free-running pulse generators with externally adjustable period and pulse. Period is variable from 0.1 to 1 sec; pulse width from 25 to 100 millisec. Completely potted timers weigh 75 grams. Built to withstand vibration from 5 to 2000 cps at 10 g and shock of 50 g for 11 millisec. Operate on 18 to 32 v dc at 60 milliamp. **Auto-Timer Div, Sloan Co, 7704 San Fernando Rd, Sun Valley, Calif.**

Circle 338 on Reader Service Card

continued on page 114

Only VALCOR makes solenoid valves of TEFLON*



*DuPont Company registered trademark.

Now, from the company that pioneered the use of Nylon and PVC in solenoid valves for corrosive service, comes a solenoid valve with a **molded body and diaphragm of Teflon** that is **chemically inert and corrosion-resistant to virtually any corrosive medium you are now using.**

Valcor solenoid valves made of all Teflon are ideal for **critically** corrosive applications and where long life is essential. They will outlast and outperform steel. Available in a variety of sizes and pressure ratings. Stocked for immediate delivery. Write today for complete technical data.

1960 DESIGN ENGINEERING SHOW | NEW YORK MAY 23 to 26

VALCOR SOLENOID VALVES

VALCOR ENGINEERING CORP.

5375 Carnegie Ave., Kenilworth, N. J. • CHestnut 5-1665

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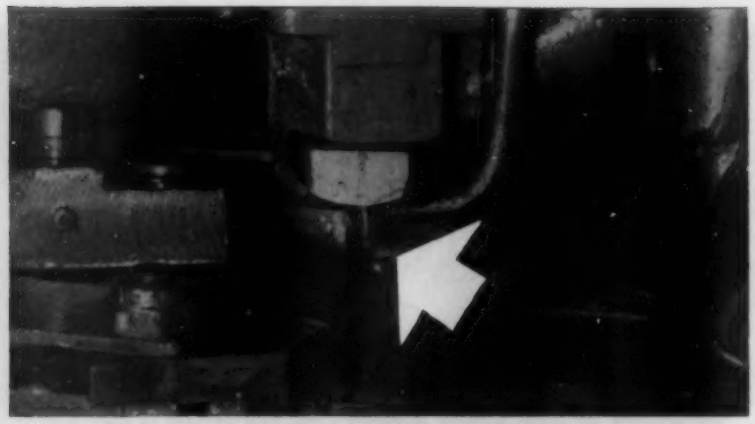


Machines equipped with the new Kennametal hard carbide nozzles spray sealing material on can lids—at 90% saving in nozzle cost.

KENNAMETAL* Carbide Nozzles outlast stainless steel nozzles by 18 to 1

When a manufacturer of cans replaced stainless steel nozzles with Kennametal tungsten carbide nozzles in machines applying a sealing compound to the metal can lids, they gained these substantial advantages:

ONE — Kennametal carbide nozzles ran 5,328 hours with no apparent wear or change in the size of the orifice. Stainless steel nozzles on the same application lasted an average of only 296 hours.

TWO — Initial cost of Kennametal carbide nozzles was more than double the cost of stainless steel nozzles. But nozzle cost was reduced 90 per cent—because the Kennametal nozzles had an 18 to 1 longer life than the stainless steel nozzles.

THREE — Kennametal carbide nozzles permitted a pressure increase from 55 to 105 psi—which resulted in more uniform coverage, improved quality and fewer rejects of cans due to sealing.

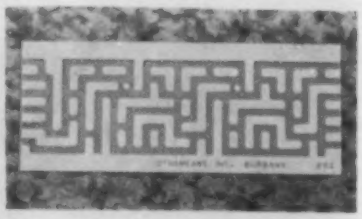
There is a good chance that Kennametal hard carbide compositions can help you solve a problem which involves corrosion, abrasion, erosion or contamination. Our group of hard carbides includes grades that last up to 60 times as long as steel—grades that are three times as rigid as steel—and grades that retain normal properties under prolonged exposures up to 2200°F (at even higher temperatures for shorter periods) and at sub-zero temperatures.

We would like you to know more about Kennametal and how it has helped others solve problems that may be similar to yours. Write to Kennametal Inc., Dept. PE, Latrobe, Pennsylvania. Ask for Booklet B-111-A, "Properties of Kennametal."

*Trademark 97203

Kennametal nozzles are designed in a broad range of shapes and sizes for varying applications.

INDUSTRY AND
KENNAMETAL
...Partners in Progress



Pre-etched circuit pattern . . .

for experimental and developmental breadboarding accommodates most circuit configuration encountered in transistor circuit design. Makes possible inexpensive construction of unlimited number of circuits since all components, including board, can be reused. After layout is completed, components are pin-soldered to board, which provides order in interconnecting process. Satisfactory breadboard layouts can be used as prototype for production run. By drilling or punching required holes in blank boards and mounting components in usual manner, board can be made part of completed design. Size is 2 x 5 x 1/8 in. Base material is epoxy glass. Price, $2. **Dynameans Inc., 1511 W Clark, Burbank, Calif.**

Circle 339 on Reader Service Card

Wall file for blueprints . . .

and large sheet drawings is available in two models that hold sheets of up to 30 in. and up to 42 in. wide. Priced at $49.50 and $63.80, respectively. Steel-tube frame is hinged to plywood mounting panel, with locking hinge support arms. Rubber-tipped lock-clips are used to mount sheets in clamp hangers. Each sheet hangs flat. **Lewbill Industries Inc, 77 Spring St, Scottdale, Penna.**

Circle 340 on Reader Service Card

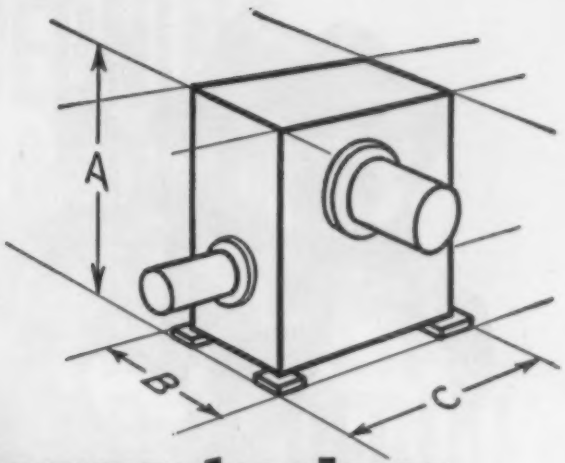
Transistorized dc multimeter . . .

is portable instrument that provides nine voltage ranges, with full-scale readings of 100 milliv to 1000 v. Accurate readings can be made down to 10 milliv range, especially advantageous in low-voltage transistor circuit measurements. Said to have voltage accuracy of 3%. Instrument

continued on page 116

(Advertisement)

Do-It-Yourself...



Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

Does this reduce load capacity? No sir! You can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

Cone-Drive Gears, that's where!

Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

CIRCLE 115 ON READER SERVICE CARD 115

CAUSTIC SOLUTION

A CASE IN POINT—This is a 19 pound Ni-Resist valve body designed to handle caustic fluids at 400 psi. It was cast for the John Bean Division of Food Machinery & Chemical Corp. Ni-Resist is ideal for this application because it combines high corrosion resistance with superior resistance to erosion from high velocity fluids.

The intricate coring required demands unusual skill to produce Ni-Resist castings leak-proof at 400 psi operating pressures. Hamilton Foundry succeeded in producing pressure tight castings, an accomplishment difficult for the best of foundrymen.

When new and unusual design problems arise in the selection of metal and the casting of parts, you will find that the skill and integrity of your foundry is your best insurance that specifications—and delivery schedules—will be met.

GRAY IRON • ALLOYED IRON • MEEHANITE® • DUCTILE (NODULAR) IRON • NI-RESIST • DUCTILE NI-RESIST • NI-HARD

HAMILTON FOUNDRY INC.

1551 LINCOLN AVENUE • HAMILTON, OHIO • TWinbrook 8-7491

116 CIRCLE 116 ON READER SERVICE CARD

has 12 current measurement ranges, with full-scale reading from 1 microamp to 300 milliamp. Five resistance-measurement ranges offer center-scale readings varying from 10 to 100,000 ohm. Battery operation eliminates power-line noise and interference and common-ground problems. Meter movement is driven by three-stage, six-transistor, high-current-gain differential amplifier. Battery life is said to be more than 400 hr. Measures about 10 x 6 x 5½ in. deep. Weighs about 8 lb. Costs $195. **Motorola Inc, 4501 W Augusta Blvd, Chicago 51.**

Circle 341 on Reader Service Card

Dc digital voltmeter . . .

for general laboratory and industrial applications converts an unknown voltage into decimal numbers with accuracy of 0.5% of full scale. Response speed is 1/24 sec for full scale. Measures 6¾ x 4⅛ x 9 in. deep. Digital presentation is bright number on dark field in viewing window. Also presents quasi-digital readout, in which numbers slide by window. Useful for observation of trends or interpolation between numbers. Input impedance is 1 megohm for all ranges. Available in 0 to 2.5, 0 to 25 and 0 to 250 v ranges at $295; in ranges of 0 to 0.25 and 2500 v at additional cost. **Electro-Logic Corp, 515 Boccaccio Ave, Venice, Calif.**

Circle 342 on Reader Service Card

Microminiature transformer kit

consists of 10 microminiature transformers, with 80 known characteristics, each encapsulated shielded case ¼ in. dia x 7/16 in. deep. Each transformer is four-winding, eight-terminal device ready for printed circuit mounting. Transformer coupling requires ⅛ power, ½ B voltage supply and results in 50% more gain than equivalent RC coupled design. Kit, from stock, $69.50. **James Electronics Inc, 4050 N Rockwell St, Chicago 18.**

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Dependable price estimates, design counsel and help, cost-cutting production recommendations—yours practically at the snap of a finger. These, and more, are the added advantages of Electric's highly automated operation together with an ideal Midwest location for on-the-job service.

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CIRCLE 206 ON READER SERVICE CARD

DISCERNING DRAFTSMEN THE WORLD OVER DEMAND IMPERIAL THE WORLD'S FINEST TRACING CLOTH

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CIRCLE 207 ON READER SERVICE CARD

The Design Equation that Saves You Money...

Use easy-to-install, economical National Retaining Rings to locate and position bearings or parts on pins, shafts and in housings. Eliminate grinding or machining shaft stock to form shoulders. You save time and material and reduce weight and space requirements. Ask for data on your specific application, today!

NATIONAL RETAINING RINGS

= improved design + economy!

ALL TYPES AND FINISHES AVAILABLE—National rings are supplied in square, round and rectangular types of carbon spring steel, bronze, beryllium-copper, stainless steel and aluminum in a wide selection of finishes. Send drawings or sample part for recommendations.

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Serving Industry Since 1886
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Nylok-Detroit is fully equipped to add locking, sealing, adjusting nylon inserts to any threaded part—*regardless of size, shape or material!* What's more, you may furnish your own parts to have the pellet inserted—or purchase complete parts processed to your exact specifications.

Special equipment geared to handle both long and short production runs assures maximum efficiency and economy. Send sample, blueprint or description for prompt quotation and delivery.

Sold through selected industrial supply houses coast-to-coast!

NYLOK DETROIT CORP.
Dept. 11 — 1100 N. Woodward Ave., Birmingham, Michigan

"NYLOK" is a registered trade-mark of The Nylok Corporation.

DESIGN LITERATURE

Marine Design Manual

By engineers of Gibbs & Cox Inc. McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 9 x 11, 376 pp. $15.

Engineers who design load-bearing structures are confronted with the same problems of stress and strain that bedevil designers of boat hulls and related superstructures. Thus this manual, though prepared by marine engineers for marine engineers, contains a substantial core of useful design techniques for any engineer interested in fiberglass-reinforced plastics. It is, in fact, the first book to combine coverage of all the basic stress situations, including buckling, with up-to-date data on laminates fabricated in production situations.

Methods, formulas, and approaches to the design of both isotropic and orthotropic laminates in tension, compression and flexure are covered in the manual. And you will find clear descriptions of molding methods used in fiberglass construction, including contact, bag, autoclave, matched die, and the newer sprayed-reinforcement technique. You also are given computed solutions in tabular form, to help you save time in solving many problems of structural-plastic application.

Sponsored by Owens-Corning Fiberglas Corp, this manual is the second in a series of books written specifically for designers and published by McGraw-Hill. The first of these was "Adhesive Bonding of Reinforced Plastics," by H A Perry, published in 1959. A third manual "Mechanical Fastening and Machining of Reinforced Plastics," is being prepared.

Introduction to Matrix Analysis

RICHARD BELLMAN. McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 6 x 9, 331 pp. $10.

Three basic fields in the analysis of matrices are covered in this book—symmetric matrices and quadratic forms, matrices and differential equations, and positive matrices and their use in probability theory and mathematical economics. Also presented is part of the theoretical treatment of the use of matrices in the computational solution of ordinary and partial differential equations by means of digital computers.

Each section includes discussions of the mathematical, physical, and economic backgrounds of the matrix theory introduced. Important chapters are included on dynamic programing and stochastic matrices. A large number of references to original papers containing further results are also given.

Emphasizing the parts of matrix theory that occur in analysis and application, the contents of this book are slanted toward the needs of analysts, statisticians, mathematicians, mathematical physicists, engineers, and mathematical economists.

Mechanical Properties of 17-7 PH and PH 15-7 Mo Stainless Steel

A W BRISBANE, Wright Air Development Center. PB-151703 (WADC Technical Report 58-400). Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 31 pp. $1.

Tensile, compression and bearing data are given for these materials at room temperature. Also presented are tensile-test results for elevated temperatures—from ambient to 1000 F. Concise and useful, it also compares strength-weight ratios of these two steels with AM-350 stainless and 6A1-4V titanium.

The Internal-combustion Engine in Theory and Practice: Vol. I

C F TAYLOR. The Technology Press of Massachusetts Institute of Technology and John Wiley & Sons Inc, 440 Fourth Ave, New York 16. 6 x 9, 574 pp. $16.

Volume 1 of this two-volume work is devoted to establishing a quantitative background for new design and development, and for the proper evaluation of the performance of existing internal-combustion engines.

Thermodynamic analyses are based on the characteristics of actual fuel-air media, and include convenient methods of comparing actual thermodynamic performance with ideal limits.

A feature of the book is the treatment of four-stroke and two-stroke air

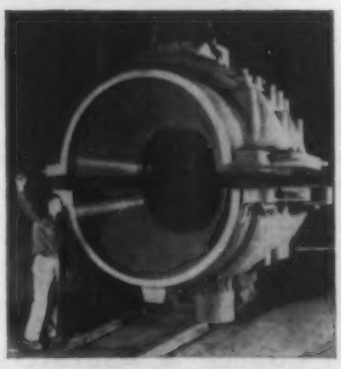
continued on page 121

Design assistance from Blaw-Knox can cut unnecessary weight, improve the service life of your product

One of the ways in which the skill of experienced Blaw-Knox steel foundrymen can be first applied to your product is in the construction of scale models of the finished steel casting. Coming at the preliminary design stage, scale models permit intensive study of ways of improving quality, eliminating weight, and minimizing machining. This design study, coming before master patterns are made, is conducted to uncover ways in which Blaw-Knox can add to the value of your product or reduce its cost.

This practical design analysis, a feature of Blaw-Knox Steel Casting Service, is of invaluable assistance to designers and manufacturers. And because Blaw-Knox, itself, is one of the world's leading manufacturers of rolling mills and industrial machines, its steel foundrymen, from patternmaker to shipper, keep end-use requirements in mind every step of the way.

If you are a designer or manufacturer of a product using cast steel components, ranging from 50 pounds to 300,000 pounds, Blaw-Knox would like to send you a copy of our brochure which details the complete Blaw-Knox Steel Casting Service. Write to the Foundry and Mill Machinery Division, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.



This upper and lower cylinder blade ring for a steam turbine was cast and machined by Blaw-Knox. Weight—55,000 pounds per half.

BLAW-KNOX

Steel Castings

CIRCLE 119 ON READER SERVICE CARD

News about R&A SINCE 1915 **Adhesives**

FOR ALL METALS AND ALL PLASTICS

Spray, dip, roller coat these epoxies to bond machineable motor stacks

3 typical Bondmaster® series "E" adhesives for bonding stack laminations:

BONDMASTER E645: Available as 1-part or 2-part with mixed viscosity in the 600-1,200 cps range. Highest bond strength and heat-resistance coupled with excellent impact strength.

BONDMASTER E621: 1-part; approximately 200 cps viscosity. High bond strength, heat-resistance and flexibility. Can be cured at low temperatures.

BONDMASTER E631: Same as BONDMASTER E621 but in a slower-drying solvent.

Since all three feature excellent mechanical strength plus resistance to many solvents, to water, atmospheric conditions, and temperature changes, they are also widely used as insulating varnishes for impregnating coils and small electrical equipment.

•

TYPICAL PRODUCTION METHODS

Most companies develop their own techniques to bond stack laminates most efficiently. The three most commonly used are:

1) Coat, stamp, and stack;
2) Stamp, pre-coat, then stack;
3) Coil or stack, then vacuum impregnate.

•

NON-EPOXIES... an alternate method

Huge electron accelerator magnet cores (a recent one involved 475 tons of oriented silicon steel laminations!) are being bonded with one of our non-epoxy solvent-dispersed rubber/phenolic adhesives. If you can heat-cure at pressures of 100 psi or more, write for information about BONDMASTER E379.

•

R&A SINCE 1915

RUBBER & ASBESTOS CORPORATION

235 BELLEVILLE AVENUE
BLOOMFIELD, NEW JERSEY

Now you can machine adhesive-bonded stack laminations of magnetic steel cores . . . machine them to tolerances as critical as you can control your equipment . . . *without fear of failures.* In addition, these laminations can now be produced without the internal stresses that have plagued the industry for so many years . . . can be made far more accurately, more uniformly, more swiftly than has ever been possible with riveted assemblies.

The "chemical fastening" of cores with BONDMASTER Series "E" adhesives is today's standard production technique in the manufacture of stators, rotors, pancake synchros, dry transformers, gyros, and servomechanisms as well as magnetic amplifiers, magnetrons, and cyclotrons.

With these solvent-dispersed thermosetting epoxy adhesive formulations, bonding is achieved by heat, alone. The only pressure you need is that required to keep the coated surfaces in complete and intimate contact during the cure cycle—a simple jig will do the job!

WIDE CHOICE OF APPLICATION METHODS

These extremely free-flowing, low viscosity (some go down to less than 200 cps) adhesives can be applied by brushing, roller coating, spraying, or dipping. Coated parts may be stored before curing for periods of up to six months, if desired. Stack laminating techniques can be adapted to *your* production set-up . . . see descriptions in column at far left.

WRITE FOR FURTHER DATA

Write for Technical Data Sheets detailing adhesive laydown, curing cycles, bonding methods, etc., of BONDMASTER Series "E" adhesives for the electrical industry.

capacity. The treatment of engine friction is new and complete, being based on extensive original research at MIT.

The material is presented in convenient quantitative form. Numerous tables and charts, ready for direct application independent of units of measure or of cylinder size, are furnished.

Aircraft and Missile Design and Maintenance Handbook

C A OVERBEY. Macmillan Co, 60 Fifth Ave, New York 11. 6 x 9, 369 pp. $9.75.

The handbook contains over 100 tables and 40 figures to illustrate and explain standard methods of equipment installation and maintenance. Data is applicable to piston-driven and jet planes, helicopters and guided missiles. Topics covered are electrical and plumbing systems, materials of construction, aircraft and missile hardware, color codes and conversion systems, plus processes such as metal spraying, anodizing, rust-proofing, plating, welding and brazing.

Other Books of Interest

Properties of Matter

Champion and Davy. Philosophical Library Inc, 15 E 40th St, New York 16. 6 x 9, 334 pp. $10.

Matter as the physicist sees it—units and dimensions, acceleration due to gravity, elasticity, compressibility, capillarity, films, kinetic theory, pressure, diffusion, viscosity.

Electrochemical Engineering

C L Mantell. McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 6 x 9½, 680 pp. $16.50.

Includes electroplating, electroforming, electrophoresis, electrorefining, electrolysis, electhermics, corrosion.

The Physics of Television

Fink and Lutyens. Anchor Books, Doubleday & Company Inc, Garden City, New York. 4 x 7, 160 pp. 95¢.

Foundations of Aerodynamics

Kuethe and Schetzer. John Wiley & Sons Inc, 440 4th Ave, New York 16. 6 x 9¼, 446 pp. $11.75.

This book gives a balanced treatment, in one volume and one terminology, of the fundamentals of the flow of perfect, compressible, and viscous flows.

Flat Rolled Products: Rolling and Treatment

Edited by T Dancy and E Robinson. Interscience Publishers, 250 Fifth Ave, New York 1. 6 x 9, 128 pp. $3.75.

Proceedings of a technical conference sponsored by Mechanical Working Committee of the

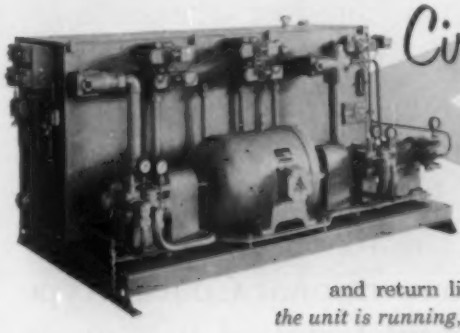
continued on page 122

CircuitPak

Low-cost hydraulic power! The CircuitPak prices hydraulic power competitively with air power, for clamping, indexing, pressing, drilling, welding, etc. Get the precise control and pressures you need, with CircuitPak.

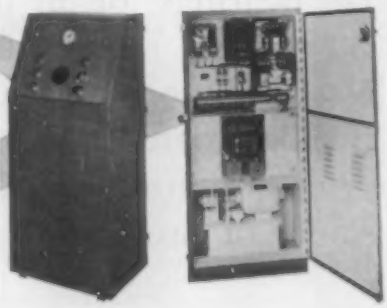
From Brown & Sharpe—

Double A Hydraulic Power Units



CircuitMaster

The unique L-shaped CircuitMaster design cuts external piping 40% or more, eliminates separate panels and manifolds. Every component is easily reached. Fluid from individual drain and return lines may be observed *while the unit is running*, for faster trouble-shooting.



Electro-Hydraulic CONSOLES

Double A builds complete hydraulic-power and electric-control packages, providing one-stop shopping for the equipment builder.

Take advantage of Double A hydraulic developments. Contact your nearest Double A hydraulic distributor. Or write to **Double A Products Co.**, a subsidiary of Brown & Sharpe Mfg. Co., Manchester, Michigan.

Brown & Sharpe

HYDRAULICS DIVISION

GEAR, VANE & CENTRIFUGAL PUMPS
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POWER UNITS

PROGRESS IN PRECISION FOR OVER 125 YEARS

GET COMPLETE INFORMATION on Double A hydraulic power units

ASK FOR the power unit bulletins

NEW HEAVY DUTY (HDR) PRECISION BALL BEARINGS

A significant step forward in bearing technology. These precision bearings combine the advantages of a maximum ball complement with deep groove ball races uninterrupted by filling notches or counterbore. The result is a new kind of ball bearing with superior performance characteristics. Up to 56 percent more capacity than conventional Conrad type ball bearings; or, in terms of life, up to 280 percent more. Also greater rigidity, less deflection, and increased resistance to shock loads. Made in standard metric series and sizes, to ABEC-3 and ABEC-5 grades of precision.

Find out for yourself — write today for catalog 60.

split ballbearing
A DIVISION OF MPB, INC.
905 HIGHWAY FOUR, LEBANON, NEW HAMPSHIRE

Iron and Steel Div, Metallurgical Society, and Chicago Section, American Institute of Mining, Metallurgical and Petroleum Engineers.

Extractive Metallurgy

Joseph Newton. John Wiley & Sons Inc, 440 4th Ave, New York 16. 6 x 9, 532 pp. $9.75.

Provides total coverage of the field, concentrating on the basic principles involved.

ABSTRACTS FROM THE LITERATURE

British Technical Sources Listed

A quick reference guide to the main sources of information useful to the designer has been specially compiled. It is presented in five pages, alphabetically arranged and tabulated.

"Where to Find Technical Information," Engineering Materials and Design, March 1960, Drury House, Russell St, London, WC 2, England.

Industrial Communications

Management is responsible for setting objectives and for seeing that they are carried out. Successful managers are able to communicate effectively. Using a man-machine analogy, the author shows how successful communications (input) can lead to greater employee response (output). Improved productivity and better morale result.

There are 10 sound rules that lead to improved communications. The objective of these rules is to make people comply. The rules are summarized.

"Industrial Communication . . . An Engineering Approach," James H. Green, Purdue University, Lafayette, Ind. Tool Engineer, March '60, 10700 Puritan Avenue, Detroit 38.

Stress Limits for Thermoplastics

Describes a testing procedure that will define the relationship among such design variables as stress magnitude, length of time of stress application, temperature of part and the amount of relaxation and creep that occurs in thermoplastic structural components.

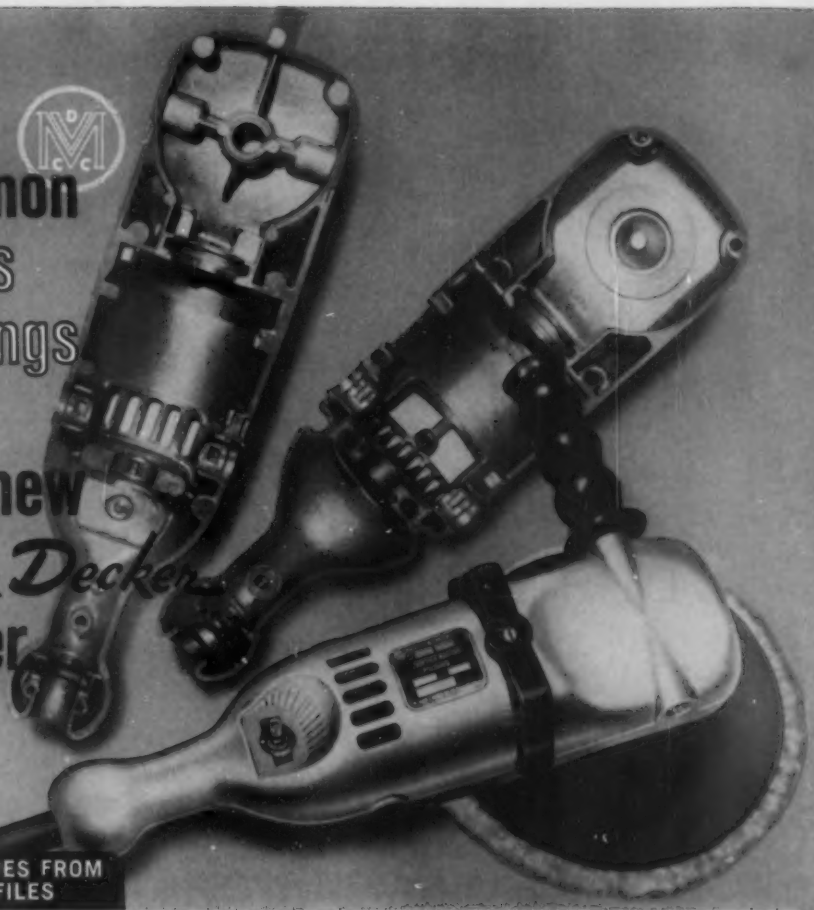
"Working Stress Limits for Thermoplastic Structural Components," Harris and Burlew, Dow Chemical Co and McGarry, MIT. SPE paper 8-1. Society of Plastics Engineers Inc, 65 Prospect St, Stamford, Conn.

Testing of Fiber Properties

Some of the techniques for testing such mechanical properties of both natural and synthetic fibers as load to

continued on page 124

Mt. Vernon reduces 5 castings to 2 in the new Black & Decker Polisher



CASE HISTORIES FROM MT. VERNON FILES

Subject:

The Black & Decker Manufacturing Company, TOWSON, MARYLAND

This new B & D "Servicemaster" Polisher—and its companion Sander, each of which sells for only $65. —contains outstanding features formerly found only in higher priced units: heavy-duty ball bearings; spiral bevel gears; recessed toggle switch, protected from dust; rugged lightweight aluminum housings.

Advanced design, which took into consideration most of the inherent advantages of high-pressure aluminum die casting, resulted in considerable manufacturing economies and an ultimate *low price tag*.

Conventional design on the regular B & D line uses 5 castings: 1-a gear case 2-a gear case cover 3-a main field case 4-a switch handle 5-a switch handle cover. In the new B & D design concept *5 parts have been combined into 2 clam-shell castings* which weigh only 2 pounds 3 ounces, a weight reduction of approximately 2 pounds over similar type polishers... the new complete "Servicemaster" polisher weighs only 8¼ pounds.

Fewer parts, however complex, mean reduction in secondary assembly operations. But despite intricate design...the superior skill of Mt. Vernon craftsmen has assured Black & Decker a steady supply of highest quality aluminum castings, economical, excellent fitting...excellently finished...requiring the least number of finishing operations.

Perhaps, like Black & Decker, you too have a cost problem. Product design with our assistance may be your answer. Let's talk it over. Just call your nearest Mt. Vernon sales representative for action.

MT. VERNON DIE CASTING CORPORATION
STAMFORD, CONNECTICUT

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BORIDES
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Leadership in high temperature technology, symbolized by the NORTON FIREBIRD, has made possible the production of the borides of chromium, titanium and zirconium in tonnage quantities.

In the METAL INDUSTRY, aluminum manufacturers utilize the low electrical resistivity and high resistance to attack by aluminum and cryolite that borides of titanium and zirconium provide. Borides are ideal boron sources for super alloys and nuclear steels . . . ROCKET ENGINE manufacturers take advantage of the superior resistance to erosion and corrosion at high temperatures that zirconium boride offers.

NORTON borides, because of their unusual properties, are being examined closely at Research and Development level as shapes and coatings for many applications.

In addition, borides of calcium, molybdenum, and vanadium are available on a limited basis for evaluation. If you have a specific requirement, let's hear about it. Write NORTON COMPANY, Electro-Chemical Division, 223 New Bond St., Worcester 6, Mass.

Send for booklet on borides and other Norton Electro-Chemicals.

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GIFTS OF THE FIREBIRD: compounds of silicon zirconium • boron • aluminum • magnesium titanium • chromium • including many borides carbides • nitrides • oxides

75 Years of...
Making better products... to make your products better

rupture, deformation, repeated stress, abrasion resistance. Some curves are included that are typical of results obtained in the testing procedures discussed.

"Mechanical Properties of Textile Materials," E. J. Stavrakas, Fabric Research Laboratories Inc. Machanical Engineering, March '60, 29 W 39 St, New York 18.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 133.

ADHESIVE PRODUCTS – Industrial manual, 78 pp. Information on physical characteristics and typical applications of line of industrial tapes, bulk adhesives, coatings and other pressure-sensitive products. Cross-indexes products by armed forces specification data, by tape type and function, and by industrial application. Mystik Adhesive Products Inc, 2635 N Kildare Ave, Chicago 39.

Circle 350 on Reader Service Card

INDUSTRIAL SOCKET SCREWS – Catalog, 82 pp. Covers design and performance information on socket screws and basic information on size, material and availability of more than 2800 items. Reviews 24 different platings and surface treatments. Standard Pressed Steel Co, Box 545, Jenkintown, Penna.

Circle 351 on Reader Service Card

DESIGNING NONFERROUS METAL-POWDER PARTS–Booklet, 24 pp. Discusses designing for pressed-brass and nickel-silver metal-powder parts. First section contains information about current materials, methods and practical design considerations. Second section presents case histories. New Jersey Zinc Co, 160 Front St, New York 38.

Circle 352 on Reader Service Card

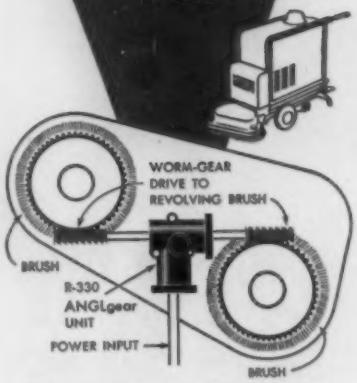
AN-NAS AIRCRAFT BOLTS–Catalog 600, 40 pp. Prepared as guide to selection of bolts for use by aircraft, missile and avionic industries. Includes 12 pages of availability charts and 18 pages of AN and NAS aircraft-bolt standards. Aircraft Bolt Corp, Sub of Elastic Stop-Nut Corp of America, 543 Monterey Pass Rd, Monterey Park, Calif.

Circle 353 on Reader Service Card

FLAME-SPRAY PROCESSES – Bulletin 136B, 12 pp. Discusses basic engineering considerations and application information on flame-sprayed coatings of metals, ceramics, carbides and other high-melting-

continued on page 127

ANGLgear simplifies power-brush drive



Cutaway shows use of 1 hp ANGLgear in brush head of LAWLORmatic 26 in. electric floor scrubber. Company employs ANGLgear in several of its other models as well.

S. C. Lawlor Co., Chicago, Ill., selected ANGLgear 90° drives for the scrubber/buffer heads of its power floor cleaners for these reasons: (1) compactness—helps cut weight and bulk; (2) high capacity—hardened bevel gears transmit more hp; (3) permanent lubrication—saves on maintenance; (4) sealed housing—eliminates possible fouling by wax or detergents.

If you have a similar 90° power take-off requirement, ANGLgear probably offers the simplest, most economical solution. Available immediately from stock, these standardized right-angle drives are easily incorporated in your power transmission systems* because of their compactness and universal mounting feature.

**Design templates free on request*

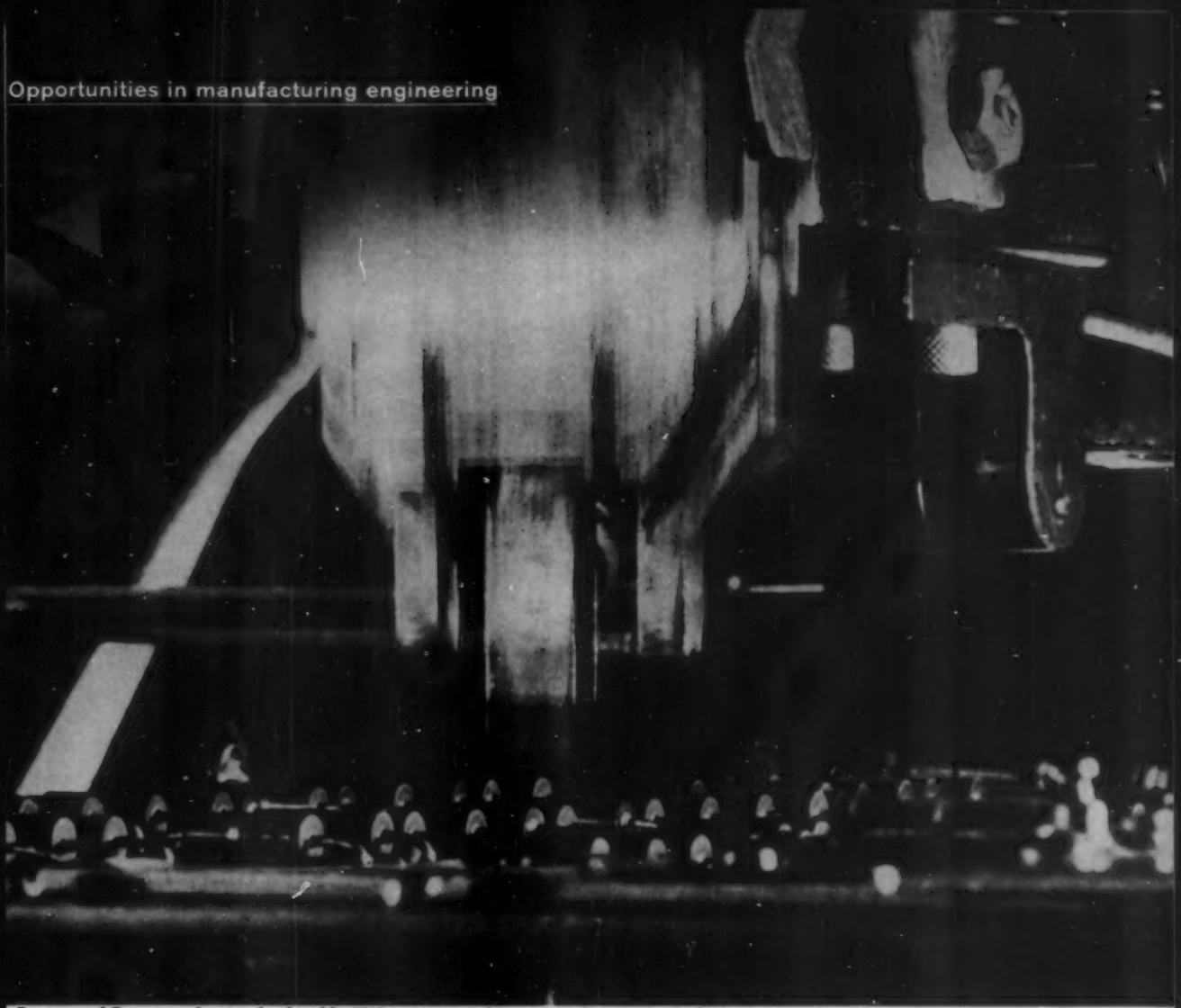
You can specify ANGLgear in ⅓, 1, 2¼ and 5 hp ratings with 1:1 or 2:1 gearing and 2 or 3-way shafting. See Sweet's Product Design File or our local distributor.

AIRBORNE

Engineered Equipment for Aircraft and Industry

AIRBORNE ACCESSORIES CORPORATION
HILLSIDE 5, NEW JERSEY

Opportunities in manufacturing engineering



Programmed Component Inserter developed by IBM engineers working in manufacturing research.

Engineering complete assembly cycles down to 1.2 seconds

In the time it takes you to read this sentence, the Programmed Component Inserter can select, position, insert, and then clinch four or five different electronic components onto a printed circuit board. This system makes possible low-cost assembly of pluggable logic units for computer applications.

How the system works—Assembly instructions are given to the Inserter by a Cardatype® reader which senses the system's punched card input. It then locates the correct position on the board, selects the right component, and inserts and clinches it. The complete cycle takes 1.2 seconds.

A single IBM card can be used to guide the assembly of any number of printed circuits—from ten units to ten thousand units. What's more, job changeover is extremely rapid because the Inserter can store 20 different types of components. At the push of a button, a new punched card is fed into position on the Cardatype reader and, in a matter of seconds, the Inserter is set up to tackle a new assembly.

Delivering high volume and efficiency—The Programmed Component Inserter was developed by IBM engineers to meet the need for high-volume, high-efficiency production of electronic components. To work in this activity an engineer must have unusual professional ability. A project like this requires the services of many types of engineers—Electrical and Mechanical Development Engineers, Test Engineers, Quality Engineers—each man making a significant contribution. It also takes the abilities of Chemists and Physicists—men who can formulate advanced manufacturing processes.

If you would like more information about the unique opportunities open to engineers and scientists in IBM Manufacturing, write, outlining your background and experience, to:

Mr. R. H. Bierly, Dept. 647 P3
IBM Corporation
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Endicott, New York

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GAST
PRODUCTS

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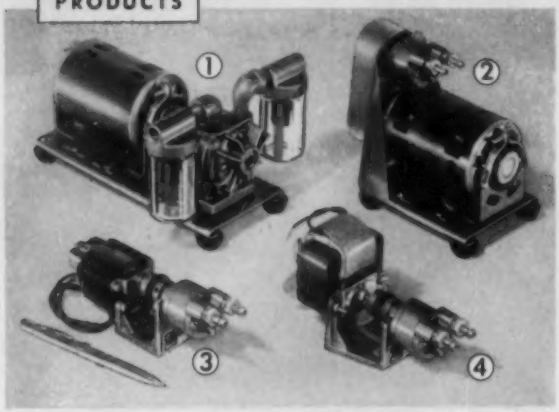

TWO TYPES OF MINIATURE OIL-LESS

GAST ROTARY VANE VACUUM PUMPS and AIR COMPRESSORS

① Model 1030-V110-206 Vac. Pump, 1/20 h.p. Up to 1 c.f.m.; to 15" vac.

② Model 0330-V112-206 split phase 1/20 h.p. motor, .48 c.f.m. Up to 20" vac. or 15 p.s.i.g.

③ Model 0330-V102A-151 series wound motor. Up to .67 c.f.m. To 20" vac. or 10 p.s.i.g.

④ Model 0330-V110-202 shaded pole motor. Up to .35 c.f.m. To 20" vac. or 10 p.s.i.g.

⑤ (Below) Model 0630-P103 Compressor, up to .6 c.f.m. To 25 p.s.i.g. or 24" vac.

FOR ORIGINAL EQUIPMENT APPLICATIONS ON CONTROLS, INSTRUMENTS, BUSINESS MACHINES, LAB EQUIPMENT

Now — where space is very limited — you can provide moderate vacuum or pressure with one of these two types (3 series) of Gast semi-miniature Air Pumps.

They run entirely without oil. Carbon vanes lubricate themselves, producing a completely oil-free air blast or exhaust. Rotary design is simple, trouble-free and positive in air displacement.

The largest Model 1030 (1 above) delivers up to 1 c.f.m. running open at 3450 r.p.m. Model 0630 (5 below) has identical exterior, delivers up to .6 c.f.m. Smaller type 0330 (2, 3, 4 above) is shown with a choice of motors to suit various pump applications, both a.c. and d.c. With a rotor diameter smaller than a penny, Model 0330 produces up to .67 c.f.m. (open) at 6000 r.p.m.!

These "semi-miniatures" may solve a problem for you — investigate today!

WRITE TODAY FOR BULLETIN M-OVP.

GAST MANUFACTURING CORP., P.O. Box 117-V
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See Catalog in Sweet's Design File

GAST ROTARY
"Air may be your answer!"

- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

CIRCLE 126 ON READER SERVICE CARD

1/2" long, .02 ounce

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for millions of silent, trouble-free on-off operations

- Requires minimum energy • SPST
- Differential angle 15° • Only 35¢ each

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NO TOOL CHARGE!

Wide selection of stock knobs, handles and plastic parts available without tooling cost to you! Many minor changes, (color, design, inserts, threads, special materials, etc.) can be made to meet your requirements.

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206 EAST SIXTH STREET • DAYTON 2, OHIO

CIRCLE 210 ON READER SERVICE CARD

point materials. Metalfizing Engineering Co Inc, 1101 Prospect Ave, Westbury, NY.

Circle 354 on Reader Service Card

CAPACITANCE-OPERATED PROXIMITY METER—Booklet TM-951-2, 28 pp. Describes device and circuit and presents dimensional information and application specifics, including layout and configuration details. Aeronautical and Instruments Div, Robertshaw-Fulton Controls Co, Santa Ana Freeway at Euclid Ave, Anaheim, Calif.

Circle 355 on Reader Service Card

MINIATURE VERTICAL-INDICATING GAGES—Bulletin 59-1, 12 pp. Describes measuring instruments for draft, pressure, differential gas pressure, temperature and for receiving pneumatic impulses. Presents gage features, mounting dimensions and lighting details. Republic Flow Meters Co, Rockwell Mfg Co, 2240 Diversey Parkway, Chicago 47.

Circle 356 on Reader Service Card

LOW-VOLTAGE DISTRIBUTION EQUIPMENT—Catalog GEC-1100B, 84 pp. Includes ratings, weights, dimensions, standard package quantities, general application information, selection data and prices. General Electric Co, Plainville, Conn.

Circle 357 on Reader Service Card

AC MAGNETIC STARTERS—Bulletin PL 12-8-160, 8 pp. Gives design and construction information on starters in sizes from 0 through 4. Describes and illustrates arc-quenching principle. Various enclosures, forms and combinations are shown. Clark Controller Co, 1146 E 152nd St, Cleveland 10.

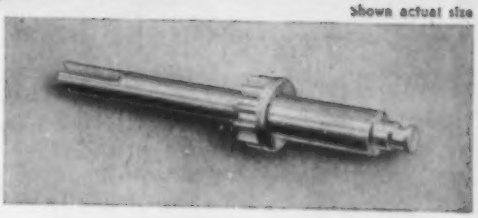
Circle 358 on Reader Service Card

TRANSFORMER AND FILTER REACTORS—Catalog CT9-59, 36 pp. Gives product specifications on over 550 units for military, industrial and communica-

continued on page 129

here's PROOF of how the GRC method cuts the cost of small parts...

Shown actual size



Take, for example, this part which previously had been produced 2 different ways...

METHOD A
ASSEMBLY OF 2 SCREW MACHINE PARTS
Screw Machine Part
Mill Slot
Machined Extrusion
Assembly
4 Production Steps
+ 3 inspections

METHOD B
CONVENTIONAL DIE CAST AND MACHINED PART
As Cast
Trimmed
Machining for Undercut and Sizing of Diameters
3 Production Steps
+ 2 inspections

the GRC method
AUTOMATICALLY DIE CAST
1 Production Step
—only one inspection

Now take a look at these comparative figures...

	Purchased Material	Cost/M	Scrap Generation	Cost in lots of 100 M	500 M
Method A	Brass	$30	30%	$70/M	$69/M
Method B	Zinc Alloy	$3.82	5%	$30/M	$28/M
GRC Method	Zinc Alloy	$3.64	None	$15/M	$11.50/M

Check the chart: you'll see clear proof of how GRC's DIE CASTING METHOD offers substantial savings on your small parts. The Gries Method delivers parts of high uniformity, with close tolerances . . . ready for use. Assembly and most other secondary operations are eliminated.

Write, wire, phone NOW for GRC's bulletin "Small Die Castings Exclusively"; send prints for quotation.

MAXIMUM SIZES: 1¾" ½ oz. No Minimum

25 years of progress in zinc die castings

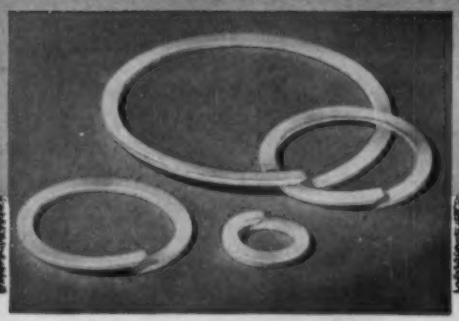
GRIES REPRODUCER CORP.
World's Foremost Producer of Small Die Castings
139 Beechwood Ave., New Rochelle, N. Y., NEw Rochelle 3-8600

PRECISION

H·I·S TEFLON*

for LIFE-TIME & TROUBLE-FREE

HYDRAULIC SERVICE



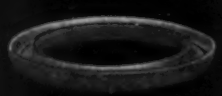
Single Turn Back-up RINGS . . .

ALL THE NEW MILITARY SIZES —
MS-28774, MS-28777 and MS-9058.

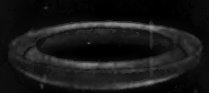
Accurately machined to assure you the fullest utility range and life of your equipment.

Only **HALOGEN** *offers* **"MEMORIZED" TEFLON**

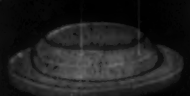
Style 310 Piston Cups



Style 614 V Rings



Style 410 U Cups and Blocked Vees



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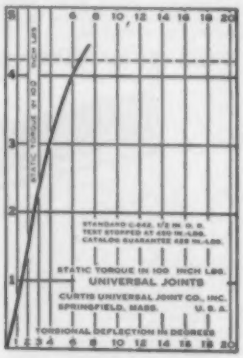
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tions applications. Chicago Standard Transformer Corp, 3501 W Addison St, Chicago 18.

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RELAYS—Catalog 160, 24 pp. Illustrations, specifications and dimensional drawings cover line of medium, small, miniature and subminiature telephone-type relays. Magnecraft Electric Co, 3350Y W Grand Ave, Chicago 51.

Circle 360 on Reader Service Card

REDESIGNED MOTOR COUPLINGS—Leaflet 2875A, 2 pp. Three new features added to line of geared, flexible, motor couplings, including corrosive-duty covers, are described in leaflet, which is being distributed with Folder 2875, NC Motor Couplings. Link-Belt Co, Dept PR, Prudential Plaza, Chicago 1.

Circle 361 on Reader Service Card

MACHINERY MOUNTS — Bulletin, 6 pp. Describes three basis types, tells how they control vibration and how they affect installation and operation. Includes loading ranges and vibration transmissibility. Unisorb, Dept WCH, 210 South St, Boston 11.

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CLOSE-COUPLED PUMP MOTORS—Bulletin MU-24, 4 pp. Describes dripproof and totally-enclosed polyphase squirrelcage motors, 1 hp and larger, with NEMA C faceplate for close-coupled centrifugal-pump applications. Wagner Electric Corp, 6400 Plymouth Ave, St Louis 33.

Circle 363 on Reader Service Card

MOTORS WITH RESILIENT MOUNTINGS—Bulletin MU-245, 4 pp. Covers mounting construction, design, performance and ratings of motors, ½ through 10 hp. Wagner Electric Corp, 6400 Plymouth Ave, St Louis 33.

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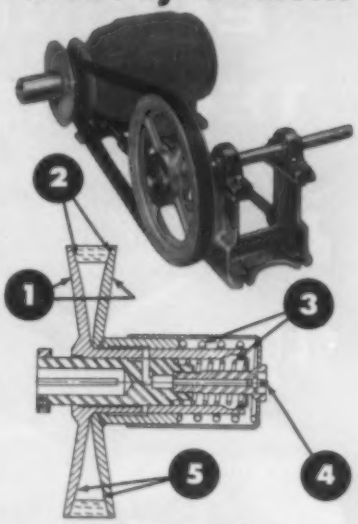
GUIDE TO FERROUS METALLURGY—Four-color wall or reference chart, 8½ x 11 in. Basic guide to ferrous metallurgy graphically illustrates relationship between temperature and mechanical and physical properties of steel; is printed on heavy coated stock for reference use. Tempil Corp, 132 W 22nd St, New York 11.

Circle 365 on Reader Service Card

INDUSTRIAL ELECTRONIC COMPONENTS—Catalogs, 26 pp. Available in seven parts for ease of reference and filing: Catalog J-101 covers industrial and military jack; J-102 covers telephone-type jacks; C-501 covers microphone, phono and RF connectors; P-201 covers plugs; S-302 covers lever-type switches; S-301

continued on page 131

feature by feature...



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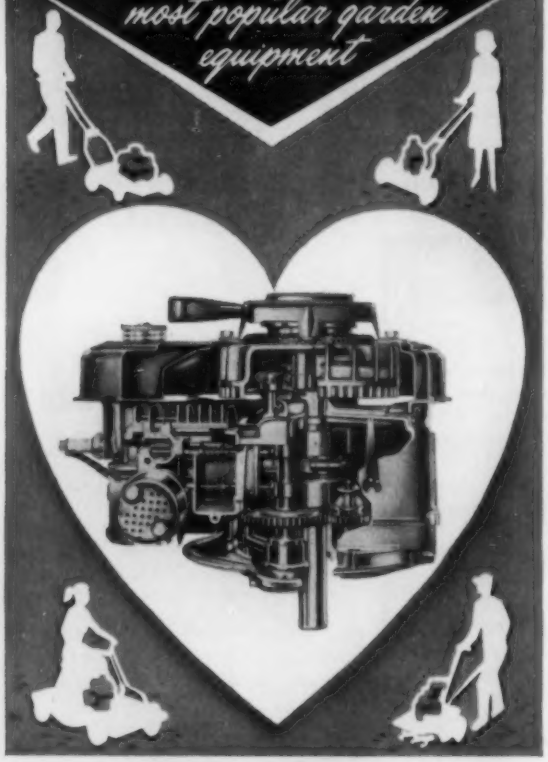

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covers button-type switches; S-303 covers miscellaneous switches. Switchcraft Inc, 5555 N Elston Ave, Chicago 30.
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PROTECTED MOTORS—Bulletin GED-4066, 16 pp. Discusses features, performance and design of integral-hp motors in general terms. Describes delivery, application aid and service. General Electric Co., Schenectady 5.
Circle 367 on Reader Service Card

APPLICATIONS FOR VULCANIZED FIBER—Vol. 1, No. 1. Correct selection and application of vulcanized fibre is illustrated and described in first issue of periodical, called "Clues." Taylor Fibre Co, Norristown, Penna.
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SOLID LUBRICANT—Bulletin 126B, 4 pp. Describes industrial application of Molykote Type G, a grease-consistency lubricant. Small sample tube accompanies bulletin. Alpha-Molykote Corp, 65 Harvard Ave, Stamford, Conn.
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AIR-COOLED TORQUE CONVERTER—Folder N1-9, 4 pp. Describes torque converter, rated at 80 ft-lb torque input, for use with engines in 10 to 50-hp class. With specifications, performance curve, dimensional drawings and cutaway view. Clark Equipment Co, Automotive Div, Jackson, Mich.
Circle 370 on Reader Service Card

VARIABLE-PITCH SHEAVES AND MOTOR BASES—Catalog SL-101-A, 8 pp. Contains specifications and illustrations of spring-loaded and manually-controlled variable-pitch sheaves and adjustable motor bases. Also includes tables of practical stock-drive combinations. Browning Mfg Co, Maysville, Ky.
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EPOXY-BASED PLASTIC PRODUCTS—Catalog, 4 pp. Outlines 25 epoxy-based plastic products, together with properties and application information. Ren Plastics Inc, 5422 S Cedar Rd, Lansing 9, Mich.
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MACHINABLE STAINLESS STEEL-BONDED CARBIDES—Bulletin 60, 2 pp. Describes physical properties and sizes of two new stainless steel-bonded carbides that are machinable. Sintercast Div, Chromalloy Corp, 132 Woodworth Ave, Yonkers 2, NY.
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MINIATURE TURRET INDEXING UNIT—Catalog sheet, 2 pp. Covers design, operation, dimensions and specifi-

continued on page 133

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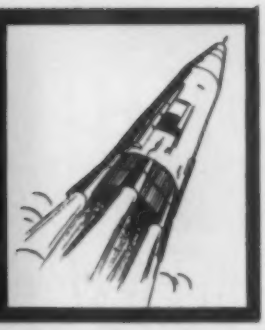

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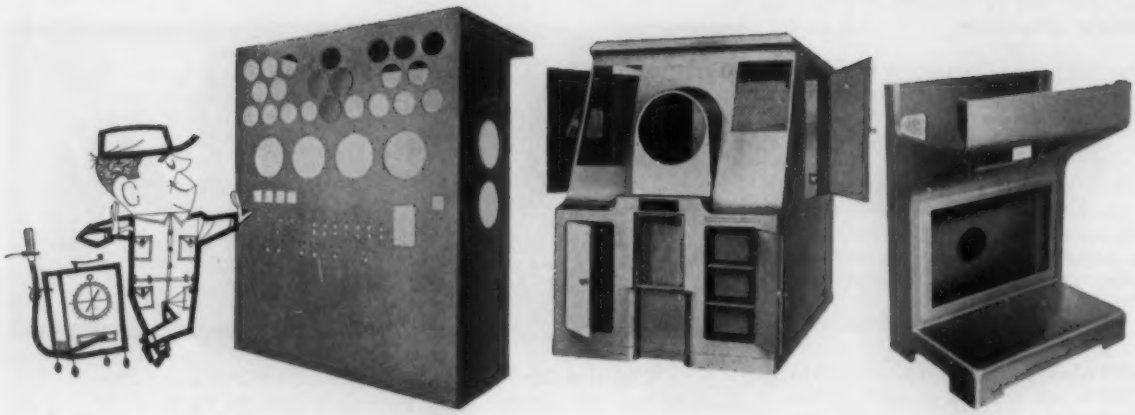

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cations of Series J unit. Swanson-Erie Corp, 814 E 8th St, Erie, Penna.
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MINIATURE INFRARED PHOTOELECTRIC SCANNER—Bulletin 260, 1 p. Describes proximity sensor, including dimensions, size and mounting specifications, delivery time and list price. Farmer Electric Products Co Inc, 2300 Washington St, Newton Lower Falls, Mass.
Circle 375 on Reader Service Card

ENVIRONMENT-FREE SUBMINIATURE SWITCH—Data sheet 169, 2 pp. Includes description, dimensions, electrical ratings, mechanical characteristics and prices of 1XE1 switch. Micro Switch, Freeport, Ill.
Circle 376 on Reader Service Card

LETTERHEAD REQUESTS ONLY

Manufacturers who published following literature asked that requests for copies be made on company letterheads.

CORROSION RESISTANCE OF VALVES—Rating guide, 8 pp. Lists relative ability of metals, plastics and synthetic rubbers used in manufacture of Flo-Ball Valves to resist corrosive effects of 390 different fluids. Includes cross-section view of valve and chemical composition of metals used in construction. Also gives physical characteristics and temperature range of plastics and synthetic rubbers. Hydromatics Inc, Livingston, NJ.

SPLIT-BODY VALVES—Catalog, 16 pp. Specifications, ratings, application information and dimensions of S- and Y-style split-body valves and various actuators, for use in selection of proper unit. Specialized constructions, materials and actuators are listed for unusual application requirements. Hammel-Dahl Div, General Controls Co, Warwick Industrial Park, Warwick, RI.

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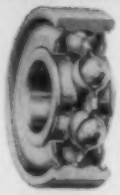

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(Advertisement)

the LEAD newsletter

Vol. 2 No. 1

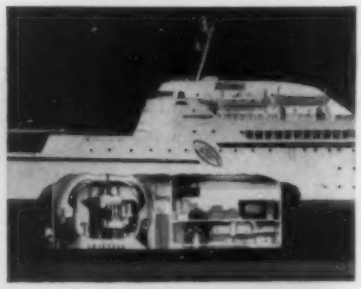
As modern as tomorrow, lead is playing an essential role in the harnessing of nuclear energy.

Improved Reactor Design

A mixture of lead pellets and organics is used by the Atomics International Division of North American Aviation in the three layer shield of their L-77 and L-47 reactors. Important savings in weight and cost are achieved by using lead's neutron reflector properties as well as its gamma shielding abilities.

The inner region of the shield is a lead pellet-diphenyl mixture. This reduces gammas and reflects or moderates escaping neutrons. The middle layer, of borated paraffin, further moderates thermal neutrons. Finally, a mixture of lead pellets and paraffin functions as the outer shield.

Advantages of mixtures of lead and organic materials: lead reflects neutrons, improving neutron economy; it reduces radiation damage of organics by absorbing energy; it absorbs secondary gamma radiation emitted by neutron capture; finally, compared to laminated lead and paraffin, the mixture has a higher thermal conductivity and specific heat, allowing higher operating temperatures without hot spots.



First Nuclear Merchant Ship

The N.S. Savannah . . . first nuclear-powered merchant ship . . . uses lead, combined with less dense shielding materials, to contain the radiation within the power plant. Lead is an ideal material . . . it can be subjected to gamma radiation and nuclear bombardment *without becoming radioactive*. Aboard the Savannah, it is effectively used in combination with water, concrete, and polyethylene to reduce weight and bulk.

"Modified Swimming Pool" Reactor

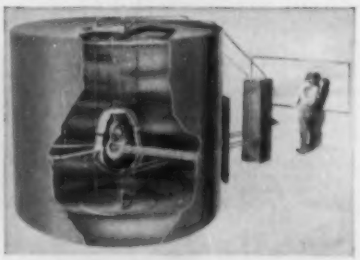
At the Naval Research Laboratory in Washington, D. C., over 20 tons of lead were used in constructing the radiation shield of a "modified swimming pool" research reactor. Designed to meet the needs of a variety of investigations in the physical sciences, the reactor provides the intense source of neutrons and gamma rays required in the laboratory's research programs. One end of the pool is a heavy lead and concrete radiation shield which includes several beam ports with removable plugs. To keep the shield thickness to a minimum, lead with its high density was a natural choice. In addition to providing efficient shielding against gamma radiation, lead *absorbs* a portion of the gamma ray and fast neutron energy entering the shield. This keeps the temperature in the surrounding concrete shield at a minimum and prevents the moisture content of the concrete from being driven off.

Beta Gage Measurements

Continuous, precise measurements of mass or density can radically improve both cost and quality of many products. These measurements are now being attained by the Beta Gage which senses the effects of mass on a radiation beam. Lead plays three important roles in this testing: it is a shielding material to protect the external surfaces of the instrument from stray radiation; it is used as a radiation beam collimator; and it is further, a "target" in generating a second type of radiation.

Isotope Utilization

The newly-constructed Cities Service Research and Development Co. Laboratory at Cranford, New Jersey, is conducting experiments on the effects of radiation on refinery processes and products. A three-pound supply of Cobalt 60, transported there in a 6,000 pound lead pig, is kept prisoner by a 12 inch lead door weighing 30,000 pounds. It can be observed through a 42 inch leaded window weighing 7,500 pounds. This 12 inch lead door provides the same effective barrier to the 5,000 curies of radiation generated by the Cobalt 60 as do the 42 inch, high-density, concrete walls which form the other three walls of the cave.



Commercialized Atomic Power

In Southern California Edison's Sodium Reactor Experiment (SRE), located about 30 miles northwest of Los Angeles, the reactor, designed to produce about 20,000 kw. of heat . . . which will be converted into approximately 6,500 kw. of electricity . . . is now operating at full power. Lead is employed to provide a safe, mobile means for loading uranium fuel . . . for removal of any hot elements penetrating the reactor core . . . and for transporting them to cleaning, storage, or hot cell facilities located in the reactor building. American International Engineers, who built the SRE, also designed and built a small 5-watt laboratory reactor for use in school, medical, and industrial laboratories. They took advantage of lead's unusual properties in employing it as a reflector shield in the reactor.

Lead is available in or can be fabricated to almost any form required to solve radiation shielding problems. In sheet, bricks, castings, extrusions, powder, pellets or shot, alone or in combination with plastics or other materials – lead is able to perform conveniently and economically. Write Lead Industries Association, 292 Madison Avenue, New York 17, N. Y. 2546

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352—Designing Nonferrous Metal Powder Parts, 24 pp, New Jersey Zinc Co.

354—Flame-spray Processes, 12 pp, Metallizing Engineering Co Inc.

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370—Air-cooled Torque Converter, 4 pp, Clark Equipment Co.

371—Variable-pitch Sheaves and Motor Bases, 8 pp, Browning Mfg Co.

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1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS

P26	P27	P28	P29	P30	P31	P32	P33	P34	P35
P36	P37	P38	P39	P40	P41	P42	P43	P44	P45

*MULTIPLE PRODUCT ADS

Key No.	Specific Product

Please print or type

Name ..... Title .....

Company .....

Street .....

City ..... Zone ..... State .....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS

P26	P27	P28	P29	P30	P31	P32	P33	P34	P35
P36	P37	P38	P39	P40	P41	P42	P43	P44	P45

*MULTIPLE PRODUCT ADS

Key No.	Specific Product

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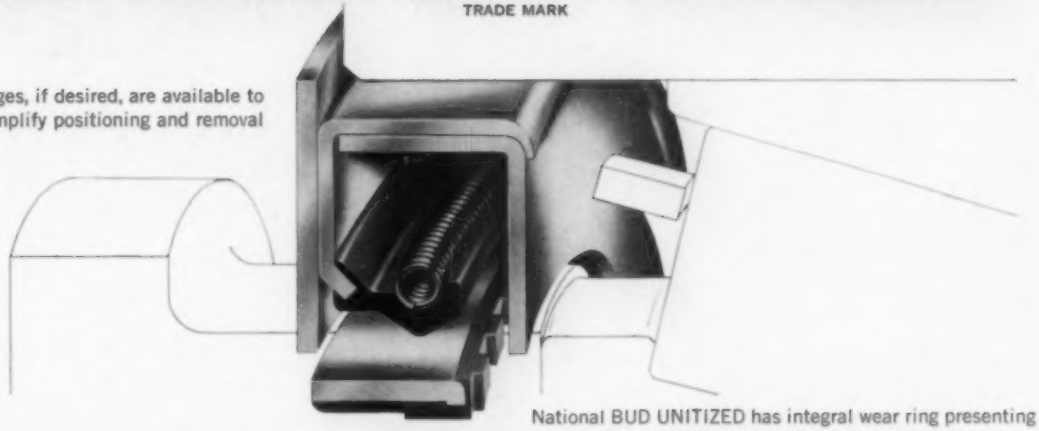

National BUD UNITIZED has integral wear ring presenting rubber surface to shaft. Wear ring turns with shaft, sealing lip is never exposed to damage, cannot score shaft.

A new unitized oil-seal-and-wear ring that eliminates:

SHAFT WEAR OR SCORING

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New National BUD UNITIZED seals are now in production, in a limited range of sizes, for heavy oil and grease sealing applications — including truck, bus and tractor uses. Still newer BUD UNITIZED seals are on the way for higher speed automotive and similar uses.

Changing a National BUD UNITIZED oil seal automatically changes the wear sleeve — in one fast, simple operation. Since the seal has its own integral wear ring, it is almost impossible to install it other than squarely on the shaft. Expensive shaft finishing is no longer a necessity, nor is leakage under a metal wear ring a problem — both thanks to the rubber surface BUD UNITIZED presents to the shaft.

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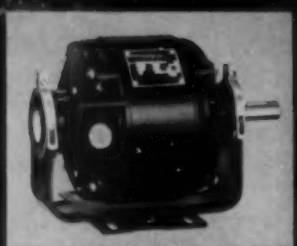

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